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KNOWLEDGE OF BIOTERRORISM MANAGEMENT AMONGST EMERGENCY  
DEPARTMENT CLINICIANS: AN EXPLORATORY DESCRIPTIVE STUDY

by

Steven Douglas Pirie

A Thesis  
Submitted to the Faculty of Graduate Studies  
through the Faculty of Nursing  
in Partial Fulfillment of the Requirements for  
the Degree of Master of Science at the  
University of Windsor

Windsor, Ontario, Canada

2008

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## ABSTRACT

**Purpose:** To develop a better understanding of the personal readiness of Emergency Department (ED) staff and senior nursing students with regard to managing a potential bioterrorism incident.

**Methods:** A cross-sectional descriptive survey using the Bioterrorism Assessment Tool was conducted to examine the factors influencing the knowledge pertaining to the health care management of victims of bioterrorism amongst ED clinicians.

**Findings:** Universally a low level of awareness and knowledge was found in all groups. Only one knowledge-influencing factor was found. The factor, internal awareness, comprised of the participant self-report on personal and ED preparedness for a bioterrorism attack entered into the model with a  $R^2$  of .062.

**Conclusion:** The sample was not prepared to deal with bioterrorism. This lack of preparedness is impacted upon by the lack of awareness and knowledge ED clinicians have with respect to bioterrorism casualty management.

## DEDICATION

I wish to dedicate this work to my father, mother, and sister who have been unconditionally supportive of my academic adventures, professional endeavours, and personality quirks. With out their constant love and support my achievements would be a mere morsel of what they have been to date.

## ACKNOWLEDGEMENTS

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## CHAPTER I

### INTRODUCTION

Infectious diseases have killed people for as long as humankind can remember. In the eleventh century, before the Common Era (BCE), man first recorded his dealings with the plague in the area around Ashdod, Israel (Scully & Kohn, 2007). The pestilence continued for many years until 400 BCE, when Scythian archers changed the course of history by first using bacteria as a means of killing their enemies. They figured out that by dipping their arrows in manure or decomposed bodies, the enemy would die more viciously and in greater numbers. Since then, man has placed dead bodies in the drinking water of his enemies; catapulted bubonic plague infected corpses over the walls of enemy cities; and passed smallpox, plague, and yellow fever laced clothing to his enemies as gifts with the intention of killing them (Smart, 1997).

The roots of terrorism are not clear, largely due to the fact that there is no universal legal definition of terrorism or terrorist (Golder & Williams, 2004; Record, 2003). It is clear however that terrorism came about much later than infectious diseases, around the late eighteenth century, with much attention brought to the subject since the 1970's (Halliday, 2001). Although governments have bantered about with the proposed or actual use of biological agents in warfare, the concept of using biological agents as a tool of terrorism against civilian populations is relatively recent. In 1972, the first stockpile of a biological agent (typhoid) was found in the possession of a Chicago based terrorist organization known as the Order of the Rising Sun. Their intention was to create a new master race by contaminating the water supplies of various cities (Andersen, 2003; Paquette, 2004).

## Significance of the Problem

The trend of finding people and terrorist organizations that threaten to use biological agents has continued since the first discovery of 1972. In 1984, the first actual use of a biological agent (*Salmonella typhimurium*) on North American soil went largely unnoticed, despite the fact that it caused 751 casualties. The incident caused no worry or panic in the North American health care community, largely because discovery of the incident was untimely, novel, and classified by the government (Miller, Engelberg, & Broad, 2001). This aforementioned incident was a clear demonstration that the problem of biological terrorism was upon our society but no one noticed its significance or cared to admit it due to the grandiosity of mitigating the situation should an attack occur domestically. The failure to recognize that the threat was real continued despite numerous expert reports on the subject (Hamburg, 1999; Henderson, 1998; Kortepeter & Parker, 1999; Purver, 1995; United States General Accounting Office [GAO], 2001). However, the attitude toward the threat of biological terrorism changed on the 4th of October 2001 following the American anthrax mail attacks. Such a change in attitude toward the threat of biological terrorism happened largely because the world was already at a heightened state of alert following the 11th of September 2001 attacks by Al-Qaeda on the World Trade Center and the Pentagon. The anthrax attacks that were launched through mailing of envelopes contaminated with white powder lead to the victimization of 22 people and exposed the lack of preparedness in both the health care community and various levels of government. As a result, health care and government agencies were forced to take a closer look at the likelihood of future biological attacks, the state of preparedness to deal with such attacks, and identify the key stakeholders who would deal with future attacks.

The assessment quickly revealed that the system was not ready to deal with the threat of another biological terrorist attack.

Following the anthrax attacks, government agencies appeared to be dealing with the potential of a biological terrorist attack more seriously. In fact, the Centers for Disease Control and Prevention (CDC) released a list of potential biological agents that terrorist organizations might use (Rotz, Khan, Lillibridge, Ostroff, & Hughes, 2002). The American intelligence community also released reports pressing that the threat of another biological terrorism event was impending (Anthrax Attacks, 2001; Cronin, 2003; United States Central Intelligence Agency, 2003). However, despite these reports and the heightened awareness of the potential of an attack, the ability to predict such attacks remains an enormous task, if not an impossible one (Dembek, 2005). This is because an attack can be launched at any scale and in various forms such as aerosol attacks (North Atlantic Treaty Organization [NATO], 2000), postal mail attacks (Paquette, 2004), and/or contamination of the food and water supply (Khan, Swerdlow, & Juranek, 2001). It is also possible that terrorists could launch attacks using conventional explosives targeting industrial, medical, and academic biological research facilities. Rail or land shipments of biological materials also pose a potential target for the terrorist attempting to release biological agents into the environment (Emergency Preparedness Canada, 1995).

In addition to the national security concerns over the potential of a bioterrorist attack, the threat of such attacks poses an immense challenge to our health care system. Thus, it is important that we be prepared to manage any bioterrorism scenario that may be launched without a previous warning and that could affect a large portion of the population. Any preparation undertaken needs to include public health epidemiological

surveillance and training of health care personnel to safeguard themselves and the public. It should also include a wide range of procedures and policies that would be initiated in the event of an attack to limit the spread of infectious diseases within hospital settings, effectively diagnose and treat the seldom seen diseases, administratively and logistically prepare for management of large numbers of casualties, manage the mental health sequelae that will likely follow an event, provide health information to the public at large, and manage the mortuary issues surrounding the recently contaminated deceased (Johnson-Winegar et al. 2005).

Despite the impact that a bioterrorist attack may have on the health care system and the society at large, it is apparent the health care community currently has significant gaps related to preparedness. This is largely because it is not clear if nurses and physicians in Canadian emergency departments (EDs) have enough training pertaining to the management of victims of bioterrorism. It is also not clear if they perceive the threat of a biological attack to be real. In addition, such an attack is likely to catch clinicians by surprise due to the inability to detect a covert release of biological agents. The impact of a bioterrorism attack will be substantial as the Canadian population is immunologically vulnerable due to the current lack of licensed vaccines against common biological terrorism agents (Johnson-Winegar et al., 2005). The current state of laboratory diagnostic capabilities in most hospitals will not support a timely diagnosis of rare and seldom-encountered biological agents furthering the lack of readiness the health care system has to deal with the threat. In fact, even when presenting conditions are finally diagnosed, we are likely to experience lack of therapeutic agents to treat a potentially overwhelming number of patients (Johnson-Winegar et al., 2005).

Given that ED staff is the frontline of the health care system in the case of a large-scale bioterrorist attack, it is particularly important that they be well prepared to deal with such a potential. In the event of an overt attack, they will need to be able to deal with victims contaminated with contagious agents and the psychological consequences that result from the attack. If not prepared, clinicians may not be able to identify the actual presence or type of biological agent in a timely manner and thus may endanger their own health when they come in unprotected contact with victims. No matter what happens, ED personnel need to be able to methodically decontaminate victims in order to render them safe to enter the ED and prevent gross infrastructure contamination; effectively care for, diagnose, and initiate treatment for a possible massing of patients; and even care for concurrent traumatic blast injuries if an explosive device was used to disseminate the biological agent. In addition, ED personnel are expected to manage the victims of a biological terrorist act, while continuing to care for their regular ED patients that they face on a daily basis (NATO, 1996). All these responsibilities highlight the importance of providing ED clinicians with all the tools at our disposal to make sure that they are well prepared to manage a bioterrorism emergency. They also highlight the importance of ensuring that proper policy and procedures are put in place in all emergency departments so that the response to such attacks be well coordinated and thought through.

### Purpose of the Study

The general purpose of this study was to develop a better understanding of the personal readiness of ED staff and senior nursing students with regard to dealing with and managing a potential biological terrorist act. Specifically, the study explored: (a) the training that health care providers who work in the ED (that is, nurses, physicians, and



senior nursing students) have received with regard to the management of victims of biological terrorism, (b) the current level of threat awareness and knowledge that these health care providers possess with regard to the issue of biological terrorism, and (c) the factors associated with the knowledge that ED health care providers have concerning the management of victims of biological terrorism.

### Relevance to Nursing

The disaster cycle represents the course of a disaster from start to finish, including the prevention of disaster, preparation for disaster, the experience of the actual disaster event, the response to the disaster, and the recovery from the disaster (Ciottone, 2006). It provides a tool for the examination of the various features of disaster planning and response, and thus is useful to registered nurses who play a significant role in the planning and management of responses to disasters (Klein 2000; Langan, 2005; Veenema, 2007a). One common responsibility that is often delegated to nurse administrators is the writing of policy and procedures pertaining to the disaster managements plan (Veenema, 2007a). In addition, nurse educators working the ED and nurses academics are expected to teach nurses and other staff members about the proper response to a disaster. This responsibility includes teaching about personal preparedness skills such as N95 / N100 protective mask fitting, clinical management of the mass casualties produced by a disaster, and coordinating disaster drills. Furthermore, nursing academics are expected to carry out the responsibility of including the theoretical aspects of disaster planning and management in university nursing programs (Stanley & Veenema, 2007). Finally, emergency nurses, especially advanced practice emergency nurses, have an important role and responsibility to conduct research related to disaster

nursing (Canadian Nurses Association, 2002; Cole, 2000; Ricciardi, Griffin-Agazio, Lavin, & Walker, 2007).

Preparing for a biological terrorist attack is one important subset of the overall set of skills of disaster planning in emergency nursing. By having a good understanding of the factors that influence the knowledge possessed by emergency nurses with regard to managing victims of bioterrorism, we can better prepare them to deal with potential attacks. Our ability to assess who amongst health care providers is knowledgeable in the management of victims of biological terrorist acts is key to effective planning for management of the consequences of an attack, educating nursing and other health care providers, and conducting further research.

This study has a special significance to nurses working within the federal and provincial governments as disaster planners. Occasionally, Canada hosts a wide variety of important national and international events such as the G8 Summit, the Olympic Games, the Summit of the Francophone Countries, and World Trade Organization meetings. Such gatherings present high value targets for terrorists wishing to advance their agenda by inflicting mass casualties. Thus, by having a tool to assess the local emergency preparedness with respect to biological terrorism they can identify the shortfalls in local ED clinician knowledge prior to the event. This in turn can result in targeted training initiatives, federal resource tasking, and financial allocation targeted at the identified vulnerabilities. These actions are critical to the processes of an effective disaster preparedness program (Keim & Giannone, 2006).

The significance of this topic and research to emergency nurses is immense. Nurses provide nursing care for individuals, families, and groups in various environments

with the goal being to promote or preserve health (Fawcett, 1996). The emergency nurse has an onus to provide the best possible care for clients and take action in a situation where the client's well-being is threatened (College of Nurses of Ontario, 2002). This includes the unfortunate client who arrives in the ED after exposure to the effects of biological terrorism. Without proper situational awareness and training, victims of a bioterrorism event will needlessly die, and nurses themselves may become casualties.

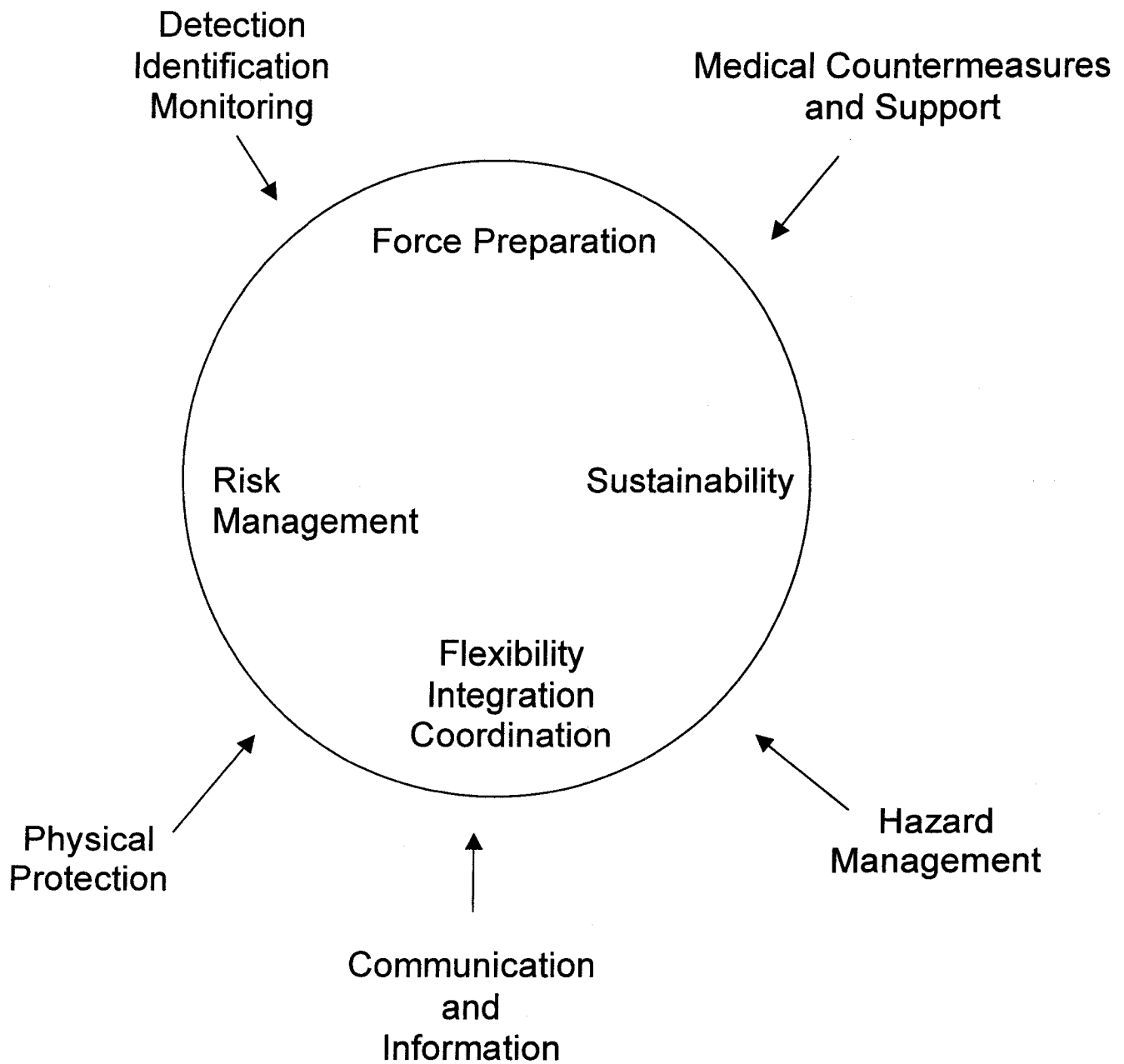
### Conceptual Framework

The Canadian Forces (CF) Nuclear, Biological and Chemical (NBC) Defence Framework was born out of the CF NBC defence strategic doctrine. It provides a theoretical framework when preparing for operations in a NBC contaminated environment (Ministry of National Defence [MND], 2005a). It is a tool for preparedness and response that is congruent with Canadian national security policy, international treaties, conventions, agreements to which Canada is a partner, command strategic guidance, NBC weapons policies, counterterrorism policy, nuclear regulation and control policy, CF industrial safety policy, and the considerations surrounding toxic industrial materials (MND, 2005b; Privy Council Office, 2004). Although the use of this framework is almost exclusively limited to the Ministry of National Defence, it has applications outside the military context. Parts of the publication series of the framework are dedicated to NBC defence during domestic operations and operational cooperation with civilian agencies. However, although unused by civilian health planners, largely due to its inaccessibility, it is appropriate for civilian use because of its strong substantive foundations, structural integrity, and functional adequacy (Smith, 2003). This framework relies on four core NBC defence principles, all equally important, which are enabled by

five components (MND, 2005a). Figure 1 displays a model describing the relationships amongst the four core concepts and the five components of the framework.

### *The Principle Concepts*

*Force preparation* is the first concept and refers to the fact that all organizations within the CF need to be prepared for a NBC event. This includes having plans, equipment, procedures, organization, and training related to NBC defence. These are seen as preliminary measures that are taken prior to exposure to a NBC event. Not only does force preparation make the organization ready to operate in a NBC environment, it also serves as a deterrent to potential enemies (MND, 2005a; United States Army, 2001). This concept has existing parallels in civilian health care. Preparing for disasters through planning, acquiring equipment, and training is not a new concept for emergency health care providers (Keim & Giannone, 2006).



*Figure 1.* The CF Nuclear, Biological, and Chemical Defence Framework (MND, 2005a)

*Risk management* is the second concept and it allows commanders and planners to focus on only the real risks that they may be facing. With an unimaginable number of potential NBC scenarios existing, energy needs to be focused on the planning and preparation for the most likely threats. This is a dynamic process and is ever evolving as adversaries conjure up new tactics and equipment. When risks are anticipated, planned for, and recognized, freedom of action is gained (MND, 2005a). The concept of risk management in the ED setting is not new and is often employed as a strategy for the mitigation of lawsuits due to adverse outcomes that commonly occur in the ED (White et al., 2005). Risk management in the ED has been used in scenarios such as preparing for violence (Bullard, Strack, & Scharoun, 2002; Knott, Bennett, Rawet, & Taylor, 2005) and disaster planning (Levi, Micheaelson, Admi, Bregamn, & Bar-Nahor, 2002). The principle of risk management is relevant for ED planners and clinicians when planning for the management of biological terrorism. It helps clinicians and planners to understand that they need not to be knowledgeable of every possible biological terrorism agent in the terrorist's disposal, but rather focus only on those that possess a moderate to high likelihood of use against the population.

*Flexibility, integration, and cooperation* compose the third principle of the framework and make reference to the fact that an adversary has a say in how they attack an organization and that this attack might not correspond with contingency plans. One of the 10 principles of war, flexibility, allows the commander and her/his staff latitude in preparing for and responding to an NBC event (MND, 2003; United Kingdom Ministry of Defence, 2002). Integration and cooperation with other stakeholders in NBC defence ensures a comprehensive interagency strategy against the threat (MND, 2005a).

*Sustainability* is the fourth concept and accounts for the increased burden in terms of personnel and supplies that will be consumed over the period of time following an NBC event (MND, 2005a). This is important because once an NBC event has occurred the management of the event will take place over an unknown and prolonged period of time. Once again, this concept is an important concept for ED managers, and disaster planners with respect to a biological terrorism event.

#### *The Enablers*

Five enablers (found in italics below) allow the aforementioned four framework principles to be attained. Within the military, they provide for activities and tasks such as planning, training, knowledge conveyance, personnel allocation, and funding. Without focusing on the enablers, the principles would be large concepts that are too abstract to manage in any practical sense.

*Detection, identification, and monitoring* allow the targeted organization the ability to realize that a covert NBC attack is occurring. Concurrently, it allows the biological agents deployed against the organization to be identified, the areas of contamination to be delineated and monitored for any changes due to weathering of the agents or the spread of contamination through natural or accidental causes (MND, 2005a). The equipment involved is often technologically complex, expensive, and is seldom used outside of the military and hazardous materials detection team setting (MND, 2005c). Although detection and identification technology have a clear use in the detection and monitoring of potentially contaminated patients, and the testing of patients after decontamination for confirmation of cleanliness, it is inappropriate to apply this

concept to the civilian ED setting until the technology to carry out this enabler is widely available.

*Communication and information systems* enable the organization affected by a NBC attack to rapidly collect, evaluate, and disseminate information regarding the NBC event (MND, 2005a). With the large volume of information required to manage a biological terrorism event, the infrequency of the use of this information, and the speed in which this information is required, this concept is relevant to ED staff.

The concept of *personal protection* from infectious diseases is not new in the ED, and is commonly found as part of the departmental infection control policy (Wilson, 2006). It allows personnel who must operate in a NBC contaminated environment the freedom to do so without the fear of illness or death. It encompasses activities such as the selection and use of individual protective equipment (MND, 2005a). This enabler is highly relevant to ED personnel who are faced with a biological terrorism incident. Without the ability to protect oneself, health care providers risk physiological and psychological harm and increase their chances of becoming casualties. Personal protection provides physical and psychological barriers to the toxic environment, thus allowing clinicians to retain some control over the presenting situation.

*Hazard management* is the process of limiting the impact that NBC agents have on the population. This can be accomplished through hazard avoidance, control of hazard spread, or decontamination (MND, 2005a). After an overt biological terrorism event, emergency departments cannot lock out potential patients thus avoiding the hazard altogether. Patients must be cared for inside the department, and hence the hazard must be managed. This is accomplished through the decontamination of overt or suspected



contamination and the isolation of infectious patients. Klein (2000) has discussed the importance of decontamination in the ED setting. The concept of isolating infectious patients is also commonly used in health care (Heymann, 2004; Wilson, 2006).

*Medical countermeasures and medical support* is an enabler that enhances the success of the principle framework concepts. These activities include the medical interventions taken in advance to minimize the impact of NBC agent exposure and the evacuation and treatment of patients once they have been physiologically or psychologically affected by NBC agents (MND, 2005a).

#### *Use of the Framework*

The CF NBC framework is an all-encompassing model for planning the response to a NBC event. It was beyond the scope of this study to utilize the full model of preparedness, and hence only parts of the framework that were directly relevant to this study were used. With respect to the principal concepts, two of the four concepts were utilized. These were the principles of force preparation and risk management. The principle of force preparation had unique applications to this study as the study examined the preparation of ED staff (that is, training and knowledge) prior to a biological terrorism event. This principle when combined with the principle of risk management forms an important aspect of the required knowledge that ED staff needs to possess. Personal protection and hazard management, in terms of decontamination and isolation, are two enablers that were of relevance to this study. In addition, the enabler that includes information systems guided exploitation of the knowledge of accessibility that clinicians may have for just-in-time information resources. The medical countermeasures enabler was examined as a concept for the mandate of treatment after a biological terrorism

attack. It is an important one for this thesis, and was examined with respect to the social and the professional mandate for ED clinicians to provide care after a biological incident.

### Research Questions

The study provided answers to the following research questions:

- (1) What training do health care providers working in the ED (that is, nurses, physicians, and senior nursing students) receive with regard to the treatment and management of victims of biological terrorism?
- (2) What is the current level of threat awareness with regard to the issue of biological terrorism among health care providers?
- (3) What are the factors associated with the knowledge of health care providers in the ED concerning the management of victims of bioterrorism?

## CHAPTER II

### REVIEW OF THE LITERATURE

#### Search Strategy

The proceeding literature was obtained through a systematic review of seven databases: Proquest Nursing Journals, PubMed, Cumulative Index to Nursing and Allied Health Literature, Medline, Ovid Nursing, Ovid HealthSTAR, and the Cochrane Database of Systematic Reviews. Additionally, theses and dissertations stored in the Proquest Dissertations and Theses database or Proquest Digital Dissertations database were searched. Keywords used in the search process included biological, terrorism, bioterrorism, nursing, nurse, physician, student, emergency, room, department, preparedness, readiness, planning, knowledge, training, education, threat, and disaster. These search terms were used in various combinations with Boolean logic operators. This approach yielded 23 published articles and no theses or dissertations.

Bibliographies of books and reference lists of articles were scanned as part of the literature identification process in order to find additional relevant articles or books. A suggestion of literature to review was also provided by various experts in the field of biological terrorism. This resulted in an additional 22 articles, 27 textbook chapters, and nine complete textbooks. The completed literature review process yielded a total of 45 journal articles, 27 textbook chapters, and nine textbooks.

#### The Review

##### *The Threat of Biological Terrorism*

The literature reveals considerable concern for the possibility that terrorists may commit further acts of terrorism using biological means. The threat of biological

terrorism could come in many forms, could be executed for many reasons, and could be perpetrated by a myriad of subversive parties. As succinctly put by Mr. Parachini, a RAND Corporation policy analyst, who said in a testimony before a United States congressional subcommittee on terrorism “Given our potential vulnerabilities, it is a small wonder that states and terrorists have not used disease more often” (Anthrax Attacks, 2001, p.2).

Since 1972, the Canadian intelligence community has extensively studied the potential of biological terrorism occurring on Canadian soil. Government experts in the field of intelligence threat assessment have concluded that the risk of a biological terrorist attack occurring in Canada is real (Purver, 1995). Terrorists view Canada as an attractive target because of its societal freedom, privilege, western world values, influence on the political stage, and military operations overseas (Privy Council Office, 2004). Kollek (2003) noted that, due to its proximity to the United States of America (USA), Canada might be used as an attack staging area and may therefore be at risk for an accidental biological agent release. An attack could also be directed at Canadian citizens simply as a result of Canada’s alliance with the USA (Kollek, 2003).

The literature also provided insight on the possible presentation of a biological terrorist attack. It suggests that the risk of an attack using biological agents is lower than that of an attack using conventional explosives (Anthrax Attacks, 2001; Artenstein, 2006). Should biological attacks occur, they would likely be small-scale in nature. Large-scale attacks are not as probable because of the technical and operational challenges in the actual delivery of biological agents (Anthrax Attacks, 2001; Artenstein, 2006). Nonetheless, it is widely feared in the literature that a modestly well-funded terrorist

organization could manufacture or acquire biological agents for dissemination (Inglesby, O'Toole et al., 2002; Regis, 1999). In fact, the United States Department of Defense undertook a study in which one million dollars was provided to three defence employees who possessed technical skills, but who had no knowledge of biological weapons. In less than one month, they were able to manufacture a biologic simulant of anthrax (Miller, 2001).

The literature widely indicated that biological agents could be disseminated in a covert manner, without public awareness of the release, or in an overt manner where the population is visibly contaminated with a biological agent (Landesman et al., 2001; Paquette, 2004; Robinson et al., 2005). The most probable means of terrorist biological agent dissemination is via airborne release. The technology to facilitate aerosol dissemination inside a building, or outside over a large area is currently commercially available to the public (Paquette, 2004; Office of Technology Assessment, 1993; World Health Organization [WHO], 1970). In an experimental study by Defence Research and Development Canada (Kournikakis, Armour, Boulet, Spence, & Parsons, 2001), investigators placed an anthrax simulant (*Bacillus globigii*) in various types of mail envelopes and had people open them in a mock office environment equipped with modern heating, ventilation, and air conditioning systems. When the airborne pattern of agent dissemination was measured, the bacteria was detected over a considerable area, revealing that even a low technology dissemination method such as spores in an envelope can pose a significant health risk.

The literature identified that contamination of food and water sources are two other methods of biological agent delivery. In these scenarios, a terrorist might

purposefully add a biological agent into the food chain, or into public water supplies (Paquette, 2004; Rotz et al., 2002). The vulnerability of the food chain and water supply is largely due to the lack of physical protection afforded through public security initiatives. Additionally, a terrorist entity may find these methods of contamination favourable due to the ease of attack, the large geographic scope of dissemination, and low probability of detection by the authorities until illness presents (Paquette, 2004).

It has been implicated that adversaries of the western world have the desire to use biological agents against a civilian population. Three creditable examples were found in the literature. These include the state that wants to attack another state by means of a clandestine act, the state that provides biological agents to a sub-national terrorist group to conduct an attack in order to maintain deniability, or the terrorist group which produces a biological agent without the aid of a state (Anthrax Attacks, 2001). In 1991, after the first war in Iraq, team members of a United Nations Special Commission found evidence that Iraq had conducted research on anthrax, botulism toxin, and *Clostridium perfringens*. This evidence was further confirmed in 1995 when United Nations inspectors found a total of 19,000 L of *Clostridium botulinum* toxin, 8,500 L of anthrax, and 2,200 L of aflatoxin (Miller, Engelberg et al., 2001; United States Army Institute of Infectious Diseases [USAMRIID], 2005; Zilinskas, 1999). Currently, Al-Qaeda presents a looming threat with respect to biological terrorism. In 1998, Osama Bin Laden publicly declared that the acquisition of unconventional weapons by his followers was a religious duty. This threat was followed in 1999 by attempts to acquire biological weapons in both Sudan and Afghanistan, and a statement by a senior Bin Laden associate claiming that his group has biological weapons. Further, bioterrorism related documents and equipment

recovered from Al-Qaeda facilities in Afghanistan showed a level of sophistication that was previously unsuspected (Boureston & Mahaffey, 2003; Paquette, 2004; United States Department of State, 2002).

In 1992, Dr. Kanatjan Alibekov (who changed his name to Ken Alibek), a senior biological warfare program manager who defected from Russia reported that Russia had an active and robust biological warfare program. This included active research into genetic engineering, binary biologicals, and the ability to manufacture large amounts of biological agents. Although Russia is no longer a substantial threat, its displaced research scientists (which once totaled 60,000 scientists) who have moved from the economically crippled Russia to many other countries around the world present a real threat. The location of these scientists is not completely known, but Libya, Iran, Syria, and North Korea are known to have been actively recruiting ex-Russian scientific expertise. There is a concern in the literature that we need not be worried only about rogue, expatriate Russian scientists and their knowledge, but we should also worry about the possibility that they have left Russia with biological cultures including smallpox (Alibek, 1999; Anthrax Attacks, 2001; Henderson et al., 1999; Miller et al., 2001; USAMRIID, 2005). Currently, between 13 and 17 nations, many of which are economically or politically unstable, are reported to have active biological warfare programs (Center for Nonproliferation Studies, 2002). The risk of terrorist acquisition of biological agents from these inadequately protected stocks of weapon grade biological agents is higher than ever (Paquette, 2004).

### *History of Use and Attempted Use*

The literature provided numerous examples of attempted or actual use of biological agents for the purpose of terrorism. The first effective bioterrorism attack was carried out in 1984 by members of a religious cult known as the Rajneeshees when dissemination of salmonella (*Salmonella typhimurium*) in Oregon, USA resulted in 751 cases of salmonellosis. This outbreak was the direct result of the production and distribution of the agent at 10 salad bars in order to affect the outcome of a local election (Anthrax Attacks, 2001; Garrent, Magruder, & Molgard, 2001; Miller et al., 2001).

Anthrax (*Bacillus anthracis*) has been the most effectively used bioterrorist weapon on American soil. In 2001, five letters containing anthrax arrived by public post to three cities. These anthrax mailings resulted in 22 confirmed cases of anthrax, five deaths, and prophylactic antibiotic treatment of 10,000 people (Inglesby, O'Toole et al., 2002; Paquette, 2004; USAMRIID, 2005). The strain of anthrax (Ames) used was a highly sophisticated, military grade quality that contained a very high microbial density of 100 billion to 1 trillion spores per gram (Anthrax Attacks, 2001; Inglesby, O'Toole et al., 2002).

Although the successful use of a biological agent by terrorists is limited to the two previously described events, many attempts to use biological agents as a tool of terrorism have been described in the literature. These include an instance of a terrorist organization in Chicago that possessed 30 to 40 kg of typhoid (Andersen, 2003; Paquette, 2004), four instances where Ricin was found in the possession of a terrorist (Andersen, 2003, Garrent et al., 2001, USAMRIID, 2005), one instance of plague (*Yersinia pestis*) possession (Carse, 1998; Garrent et al., 2001; USAMRIID, 2005), and the attempts of the Japanese



cult Aum Shinrikyo to use anthrax, botulism, Q fever and Ebola against the citizens of Japan (Kaplan, 2000, Murakami, 1998/2000; Paquette, 2004; USAMRIID, 2005; WuDunn, Miller, & Broad, 1998).

#### *Potential Biological Agents Available for Use*

The United States CDC conducted a landmark public review of biological agents that could be employed as tools of terrorism (Rotz et al., 2002). Subsequently, they developed critical biological agent categories for public health preparedness using a risk-matrix analysis process. These categories (A, B, and C) provide a starting point for planners attempting to identify potential threat agents. Agents were categorized according to a ranking system that examined public health impact in terms of mobility and mortality, potential for production and dissemination, communicability, public perception, and special preparations required. Category A agents were deemed to have the greatest threat of employment and included *Variola major* (smallpox), *Bacillus anthracis* (anthrax), *Yersinia pestis* (plague), *Clostridium botulinum* (botulism toxin), *Francisella tularensis* (tularemia), *Filoviridae* (Ebola and Marburg), and *Arenaviridae* (Lassa). Category B agents were the next level on the threat continuum. These agents included *Coxiella burnetii* (Q fever), *Brucella* species (brucellosis), *Burkholderia mallei* (glanders), *Burkholderia pseudomallei* (melioidosis), alphaviruses (Venezuelan equine encephalitis, eastern equine encephalitis, and western equine encephalitis), *Rickettsia prowazekii* (louse-borne typhus fever), toxins (ricin and staphylococcal enterotoxin B), *Chlamydia psittaci* (psittacosis), *Salmonella* species, *Escherichia coli* O157:H7, *Vibrio cholerae*, and *Cryptosporidium parvum*. Finally, category C agents were identified as

agents that present an emerging threat. Nipah virus and *Hantavirus* were listed as the only two category C agents (Rotz et al., 2002).

The literature has also surprisingly identified various other agents not listed by the seminal works of the CDC that could be employed in bioterrorism. These include influenza (Cheh, 2006; USAMRIID, 2005; Vorobjev et al., 1997), *Rickettsia typhi* (flea-borne typhus fever) (Vorobjev et al., 1997), T-2 (trichothecene) mycotoxin (Fung, 2006; USAMRIID, 2005), and severe acute respiratory syndrome (SARS) coronavirus (Shepherd, Cunnion, & Shoff, 2006; USAMRIID, 2005).

### *Preparedness to Respond to a Bioterrorism Incident*

#### *Professional Mandate*

The literature provided a clear professional mandate for nurses and physicians working in the ED setting to provide care after a biological terrorism incident. For the nurse with specialty certification in emergency nursing, the Canadian Nurses Association (2006) states that an emergency nurse must be able to ensure safety of the environment from toxic biological, chemical, or radiological contamination. This includes initiating decontamination procedures, providing care for the patient with infectious diseases, and initiating isolation precautions when warranted. Although the College of Nurses of Ontario (2002) does not specifically address bioterrorism preparedness, their standards of practice suggest that registered nurses are responsible for having the knowledge relevant to their area of professional practice. The Emergency Nurses Association provides emergency nursing certification in the USA. The core emergency nursing competencies with respect to disaster planning and management are considerably clearer and better stated than the Canadian competencies (Klein, 2000). Specifically, testable core

competencies exist in the identification and management of patients, who have been exposed to a biological, or toxin agent. Although it made no specific reference to biological terrorism management, the Royal College of Physicians and Surgeons of Canada (2003) recommends that all emergency medicine physicians be required to have expertise in disaster management. Further, no reference in the literature could be found for nursing students practicing in ED settings during a disaster.

DiMaggio, Markenson, Loo, and Redlener (2005) conducted a random survey that examined willingness of 1,919 American paramedics to report to work after a variety of disaster related events. Despite the clear professional mandate indicated by the study, the authors concluded that only 64.8% of paramedics would be willing to report to a limited (10 hospitals, 200 patients) smallpox outbreak. This was considerably lower than the willingness to respond for events related to a major snow storm (84.1%), fire with 1,000 smoke inhalation casualties (87.5%), or an explosion with 2,000 casualties (87.7%). Surprisingly, the willingness to respond was even higher (74.3%) for a chemical terrorism event with 5,000 casualties, or a radiological terrorism event (73.8%) with 500 casualties than a biological terrorism event. Of the paramedics who indicated a willingness to respond to any disaster situation, 83.3% cited a sense of responsibility as their reason for doing so, while 69.9% indicated it was part of their professional code of ethics. This work provides insight into a potential conflict between professional mandates versus willingness to respond. Because these results are not generalizable to the Canadian health care system, or to nurses and physicians working in ED settings in Canada, it is not known if these groups of health care professionals would respond similarly.

### *Bioterrorism Incident Preparedness*

Chen, Hickner, Fink, Galliher, and Burstin (2002) found that family physicians who felt prepared for a natural disaster were four times more likely than other doctors to know how to respond to a biological terrorism attack (35% versus 9%,  $p < .001$ ). Although this is an interesting finding, the authors did not explore the factors that lead physicians to consider themselves prepared for a disaster. The literature is not clear with respect to what constitutes preparedness of ED or which competencies lead to a state of preparedness. The lack of clear direction for ED preparedness is likely due to the fact that the topic is interdisciplinary in nature (for instance, clinicians, policy makers, engineers, public affairs), and complex with respect to the myriad of possible disaster types and the impact that the disaster may have upon ED operations (Klein, 2000). It is suggested however that for EDs to be prepared for NBC events clinicians must have an awareness of the threat of an attack (Beaton, 2002; Chen et al., 2002; Kollek, 2003). It was also found that knowledge attained through education is paramount to preparedness (Pavlin, 1999; Stanley & Veenema, 2007; United States Public Health Service [USPHS], 2004) and that ED clinicians should have formal training in disaster preparedness and management (Gebbie & Qureshi, 2002; Klein, 2000; Langan, 2005; Stanley & Veenema, 2007; Veenema, 2007a).

### *Biological Terrorism Awareness*

The literature showed that having an awareness of how biological terrorism acts may be employed against the population, what biological agents a terrorist could use, and how probable the clinician feels an attack may be is fundamental to the concept of preparedness for a bioterrorism incident (Ackerman & Moran, 2004; Beaton, 2002;

Chang, 2006; Croddy & Ackerman, 2007; Kollek, 2003). Although the importance of awareness has been identified for NBC disasters, and appears frequently in anecdotal checklists for bioterrorism preparedness, it has not been scientifically studied in ED settings with respect to biological terrorism. Only Beaton (2002) explored awareness by utilizing a questionnaire that examined potential terrorist biological agents and the perception of threat. This study was not limited to the awareness of biological terrorism threat, but rather explored the entire range of NBC events. It also utilized an American paramedic sample, which may not be generalizable to Canadian ED clinicians as the level of training, possible threat awareness, and health care system structure is not congruent between the two populations.

#### *Education and Knowledge about Biological Terrorism*

Understanding the adequacy of knowledge possessed by emergency clinicians is of prime importance in preparing for a bioterrorism event (USPHS, 2004). The literature was reviewed in an attempt to find studies that examined the relevant content and knowledge of nurses and physicians. The literature identified three areas of knowledge as important competencies for nurses and physicians to possess. These include the ability to decontaminate and isolate patients, and the act of protecting oneself and thus allowing safe care to the patient to be rendered. It is generally accepted that education and training increases competence and knowledge in the ED (Bracken & Martinez, 2000). However, no literature could be found that examined the factors affecting the knowledge that ED clinicians possess with respect to health care after a bioterrorism event.

## *Education*

Three studies of interest with respect to education and bioterrorism were found. One examined general training levels (Ghilarducci, Pirrallo, & Hegmann, 2000), another examined school curricula (Markenson, DiMaggio, & Redlener, 2005), and the third evaluated concrete knowledge with respect to physicians and biological terrorism (Chen et al., 2002). Ghilarducci et al (2000) examined the training level of ED nursing staff, physicians, and security and auxiliary personnel with respect to casualty management in patients presenting from a hazardous materials incident. The researchers divided the concept of training into two categories: awareness training (at least four hours) and operations training (at least eight hours of training). Participants provided information pertaining to total number of hours they had with respect to training about bioterrorism. Participants were 5,654 nursing staff working in 119 level-one American trauma centers and 1,806 physicians working in 117 level-one American trauma centers. The study concluded that overall only 36% of the staff had received training, with physicians having more awareness training than nursing staff (35.3% versus 23.4%, respectively). The findings however suggested that the two groups had approximately the same levels of operational level training (physicians 9% versus nursing staff 8.8%). When the readiness of each the trauma centre ( $n = 156$ ) was examined, only 16.7% ( $n = 26$ ) centres had 10 or more operationally trained staff in the ED. Only 28.8% of the participants acknowledged having one or more hours of hazardous materials training per annum. These rates are congruent with those reported by Chen et al. (2002) who found that only 18% of family physicians had received any prior training in bioterrorism preparedness.

Markenson et al. (2005) identified the need for education for health professionals with respect to how to respond to a chemical, biological, radiological, nuclear, or explosive terrorist incident. The authors suggested that many of the necessary topics that are relevant to such terrorist incidents are already part of existing curricula and are taught as part of other subjects such as infectious disease, public health, or epidemiology. Despite this observation, only one of the 25 American medical schools that were examined had a requirement for formal training in bioterrorism. The authors pointed out that many medical schools attempt to address this lack of content pertaining to bioterrorism with continuing medical education courses. The authors criticized this approach to education because continuing education courses are general and do not address the clinical role in the ED. In fact, the authors concluded that there is a clear need to incorporate terrorism preparedness training to the curricula of professional health programs. They proposed core competencies for nursing, dental, and medical schools, as well as schools of public health. Of particular interest was a core competency for nurses to have level three (application) competency (of six levels [knowledge, comprehension, application, analysis, synthesis, and evaluation] in the cognitive domain of Bloom's Taxonomy) to assist them to identify and understand the epidemiology, route of exposure, treatment, and infection control practices for agents that are classified by the CDC as category A agents. Physicians were recommended to have only level two competency (comprehension) for this same task standard. With respect to category B bioterrorism agents, nurses were expected to have level one competency (knowledge), while physicians were expected to have level two competency (comprehension).

Although an attempt through this review of the literature was made to ascertain the existence of bioterrorism education in nursing programs, no information could be found.

### *General Knowledge*

Chen et al. (2002) conducted a random survey of 614 family physicians and found 95% believe a bioterrorist attack in the United States is a real threat. When asked to indicate which biological agents they thought were most likely to be used in a biological terrorist attack, they gave seven responses. Six of those conformed to the CDC's category A agent list (anthrax [cited by 96 % of participants], smallpox [82%], plague [28%], botulism [22%], Ebola [16%], and tularemia [11%]). Nerve gas was the seventh agent (14%), which reflects confusion over the difference between biological and chemical agents. It was reported that family physicians who have received bioterrorism training were three times more likely than other physicians (55% versus 20%,  $p < .001$ ) to report that they knew how to respond to a bioterrorist attack. This was one of the few studies found with respect to clinician threat perception. It surveyed only family medicine physicians in the USA and therefore is not generalizable to other health care providers, such as nurses, or to the Canadian health care system.

### *Knowledge about Decontamination*

The purpose of decontamination by health care providers is not to lessen the damage done to the patient, but to limit the spread of contamination and reduce the potential reaerosolization of the biological agent (Burenzvig, 1992; Franz, 1997). It was noted as a fundamental component of protection in the hospital setting (Macintyre et al, 2002; USAMRIID, 2005; USPHS, 2004) and care of casualties thought to have been overtly exposed to biological agents. Most biological agents (except mycotoxins) are not



dermally active and hence the risk of disease contraction through intact skin is inconsequential. All decontamination must occur before the contaminated patient enters the ED in order to prevent facility compromise through contamination. No studies could be found in the literature that identified the actual knowledge possessed by ED clinicians on the topic of decontamination.

### *Knowledge about Personal Protection*

The literature provided numerous references suggesting that possession and correct use of personal protective equipment (PPE) is paramount to reducing the risk of spreading communicable diseases both to staff and other patients in the event of a bioterrorism attack (Grow & Robinson, 2003; Henderson et al., 1999; USPHS, 2004). Markenson et al. (2005) suggested that both nurses and physicians should be able to demonstrate proficiency in selecting and using PPE in a range of bioterrorism situations typical to one's health profession. However, the authors did elaborate further with regard to the specific knowledge required. Secor-Turner and O'Boyle (2006) conducted a literature search of Ovid-Medline and PubMed with an aim of identifying works that examine the psychological impact of disaster work, nurses, and bioterrorism. Their search revealed reports suggesting that possessing and understanding the use of PPE is important in reducing the psychological implications on health care staff during and after a biological terrorism attack. It was identified that a situation would "feel" less dangerous if a person can have a sense of control and that PPE provides this sense of control to some undetermined degree.

Given the variations in PPE requirements based on the biologic agent, there is a risk for confusion among health professionals with regard to the selection and use of

PPE. Despite the importance that health care professionals be knowledgeable about PPE and how to use them, little is known about health care professionals' preparedness for a bioterrorist attack as it relates to the use of PPE. In fact, no studies examining the actual knowledge of clinicians in the ED with respect to selection and use of PPE could be found.

### *Knowledge about Isolation*

In addition to PPE, isolation of patients who have been exposed to contagious biological agents is a key component of managing a biological terrorism event (Grow & Robinson, 2003; McKinney, Wesley, Sprang, & Troutman, 2005; USAMRIID, 2005; USPHS, 2004). Depending on the biological agent of exposure (standard, contact, airborne, or droplet), precautions must be maintained (Grow & Robinson, 2003; Henderson et al., 1999; Inglesby, Dennis et al., 2000; USAMRIID, 2005). The importance of isolation as a manner of containing infection was underscored in the literature with reports from the SARS outbreak. With respect to SARS, 77% of probable SARS cases in Canada were the result of in-hospital exposure (Grow & Robinson, 2003). Similarly, the Director General of Health for Taiwan reported that 94% of SARS infections in that country were transmitted inside hospitals (McNeil, 2003). Although not a prototypical biological terrorism agent (but a potential agent), the SARS experience serves as an excellent example of the importance of isolation for an emerging, airborne infection. Only one author (Robinson et al., 2005) noted the importance of ED staff correctly utilizing isolation. No studies could be found with regard to knowledge of ED clinicians with respect to appropriate isolation measures after a biological terrorism incident.

### *Biological Terrorism - Immediate References*

Given the large amount of knowledge required by clinicians for the management of biological terrorism incidents, it is important that they be aware of available resources. McKinney et al. (2005) stated that detailed just-in-time resources for clinicians are of critical importance to frontline workers. Ghilarducci et al. (2000) identified the need to have ready reference materials (books) on the subject of chemical accidents or terrorism in the ED for use by the staff at the time of a crisis. In the study by Ghilarducci et al. (2000) of 156 level one-trauma centers in the United States, they found that 81.4% had at least one chemical response reference available. No information was reported on the accessibility of biological terrorism treatment references.

The aforementioned literature reveals that a substantial focus has been paid to the actual security threat of bioterrorism and its biological agents. However, no studies were found that examined knowledge, awareness, and perception levels of ED clinicians with respect to management of a bioterrorist event. Given the importance that ED clinicians be well versed in this content area, research is needed to determine the extent of their knowledge levels. Such a study is likely to provide a much-needed assessment of ED clinicians' knowledge, identify potential knowledge deficits, and make future curricular recommendations to overcome these deficits.

### *Summary of the Literature Review*

The literature identified the clear possibility and threat of a future biological attack on the Canadian population. This was evident in terms of terrorist motivation for use, as evidenced by past use or attempted use of biological agents by terrorists and the

technical means of executing a biological terrorism attack. A substantial list of possible biological agents for which terrorists might opt to use was discovered.

It is almost universally agreed upon that ED nurses and physicians have a professional mandate to be prepared for all disasters, including a biological terrorism attack. Gaps exist in the literature as to what is an acceptable level of preparedness or what features constitute ED preparedness for a bioterrorism event. It was identified that threat awareness and knowledge are fundamental to the concept of preparedness. Large gaps exist in the literature with respect to how to evaluate threat awareness, or what actual level of threat awareness ED clinicians have with respect to bioterrorism.

Knowledge was often related to education and training in the literature. No bioterrorism knowledge evaluation tool, or the level of knowledge ED clinicians have with respect to bioterrorism health care could be found. Although the topics of decontamination, isolation procedures, and PPE were frequently identified as core knowledge requirements for emergency clinicians, little is known about the current level of knowledge that ED clinicians possess with respect to these content areas.

Public health workers, (Hamburg, 2001; Kerby, et al., 2005; Landesman, et al., 2001) the prehospital emergency medical services population, (Beaton, 2002; DiMaggio, et al., 2005) academic educators teaching health care clinicians, (Markenson, et al., 2005; McKinney, et al., 2005) and family physicians (Chen et al., 2002) have been previously studied with respect to biological terrorism preparedness. However, there is a dearth of literature that examines ED clinician's awareness and knowledge for a bioterrorism event, as most previous studies concentrated on a chemical, or a general hazardous materials incident. Although important, knowledge, techniques, and preparation for

managing a chemical terrorism event, or an industrial chemical accident are considerably different than a biological terrorism incident.

In summary, the literature indicates there is a threat of biological terrorism, and emergency clinicians should be able to manage patients resulting from such an incident. Literature has been published on what emergency clinicians should know and the skills, techniques, and procedures to manage a biological terrorism situation. The clear gap in research, which emerged from this literature review, is the actual awareness and knowledge that Canadian ED clinicians have with respect to biological terrorism.

## CHAPTER III

### DESIGN AND METHODOLOGY

#### Research Design

A cross-sectional descriptive survey was conducted to examine the factors influencing the knowledge pertaining to the health management of victims of biological terrorism amongst ED clinicians. The study compared the responses of ED registered nurses, physicians, and senior nursing students at a single time interval.

#### Setting and Sample

Study participants were recruited from a faculty of nursing at a Canadian university and two Canadian EDs located in the same city. Participants from the university were fourth year baccalaureate nursing students, while participants from the hospital sites were registered nurses and physicians. Both EDs receive approximately the same volume of patients (approximately 55,000 visits per year). A convenience sampling technique was utilized to recruit 130 participants from the three research sites. This sample size was calculated according to Tabachnick and Fidell's (2001) formula ( $N \geq 50 + 8m$ , where  $m$  is the number of independent variables). Thus, with an estimated number of 10 independent variables, the sample should consist of 130 participants. This sample size is within the limits of Stevens' (2002) rule of thumb that suggests 10 to 15 participants for each independent variable. Given that only nine variables were included in the regression analysis, the sample of 130 participants was more than sufficient.

#### Inclusion Criteria

Eligible participants met the following inclusion criteria:

1. Be a registered nurse or physician who works full or part time in the ED; or

2. Be a fourth year nursing student who is enrolled in a Bachelor of Science in Nursing program.

### Variable Definitions

#### *Conceptual Definitions*

##### *Biological terrorism*

A concrete definition of terrorism or biological terrorism is not universally accepted by governments, scholars, or lawyers (Golder & Williams, 2004; Record, 2003). However, terrorism has been conceptually defined as the unofficial (not sanctioned by a legitimate government) use of violence and intimidation as a means to achieve political aims (Soanes & Stevenson, 2005). Thus, biological terrorism, or more colloquially, bioterrorism is the use of an infectious agent, harmful biological, or biochemical agent in order to cause violence or intimidation as a means of achieving a political aim (Soanes & Stevenson, 2005).

##### *Knowledge*

It has been proposed that knowledge is any piece of information that is justified, believed to be true, and simply results due to sense perception (Plato, n.d./1986). Conceptually, it is best defined as information and skills attained through education, experience, theoretical, and/or practical understandings of a given subject. It is also defined as the sum of what is known on a topic (Soanes & Stevenson, 2005). For the purpose of this study, knowledge of bioterrorism was defined as the sum of information that a clinician understands on the topic of health care management of bioterrorism victims including isolation, decontamination, and personal protection.

### *Awareness of threat*

There is no definite conceptual definition of the concept “awareness of threat.” However, given that the legal meaning of a threat is defined as something that could cause bodily harm and thus limit personal or societal freedom of action (Soanes & Stevenson, 2005), awareness of threat could be defined as the perception of an individual or a society of the likelihood that a potentially harmful threat is real.

### *Operational Definitions and Instrumentation*

No instrument that operationalizes preparedness as measured through awareness of threat and knowledge pertaining to biological terrorism among ED clinicians could be found in the literature. Thus, the Bioterrorism Assessment Tool (BAT) was specifically developed for the purpose of this study to provide a measurement tool of these two concepts. The BAT is composed of three sections that solicits information about the demographic characteristics of participants, their awareness of threat, and their knowledge with respect to the health management of biological terrorism victims (see the Appendix).

The demographics section of the BAT identifies the participants’ profession, highest level of schooling, age, gender, certification, if the participant has worked in an American ED in the past five years, and years of professional and ED experience. The demographic section also contains three questions that solicit information pertaining to the amount, nature of training received in the area of health management of biological terrorism, and the clinician access to just-in-time information on the topic of bioterrorism while working in the ED.



The awareness of threat section contains six questions that explore the clinicians' awareness of the threat of bioterrorism. The first two questions of this section use a Likert-type scale to explore the feeling the clinician has with respect to the probability of a biological terrorism attack occurring somewhere in Canada, or in their city over the period of the next 10 years. This is followed by two additional Likert-type questions that explore participants' perceptions of the level of preparedness they and their ED have to respond to a biological terrorism incident. The remaining two questions of this section examine the awareness/recollection that participants may have about biological terrorism threats or attacks that have occurred in the past 35 years and the awareness of the biological agents that may be used in bioterrorist attacks. These last two questions provide participants with a list of 10 options, from which only five are correct. Each response was awarded one point for each correct answer or one negative point for each incorrect answer. Thus, the scores on these two questions may range from negative five (the lowest possible score) to positive five (the highest possible score). The awareness scale was not treated as a psychometric scale. Instead, each of the six items on this section was treated as unique units of analysis (that is, a single item measure).

The third section of the BAT provides a psychometric tool to measure the knowledge of the participants with regard to biological terrorism. It focuses more specifically on knowledge related to areas of decontamination, isolation, and personal protection that clinicians are anticipated to possess with respect to the health management of a biological terrorism event. Knowledge pertaining to these areas is assessed through the use of four scenarios that present different possible biological terrorism events (mail attack, protest attack, explosive attack, and clandestine discovery), each with a different

biological agent, (Ebola, ricin, or unknown agents) and different methods of presentation to the ED (surprise arrival with no decontamination, decontaminated at the scene, mass casualty event with contaminated, seriously injured patients, and presentation after a low probability of exposure, sometime after the event, with self decontamination). At the end of each scenario, a question examines the patient decontamination requirements, isolation requirements, and the staff personal protection requirements that are appropriate for the situation. The situations were scored with one point for a correct answer and negative one point for an incorrect answer. The highest possible score on knowledge is 12 and the lowest possible score is – 12. Given that the questionnaire has not been validated in previous research, it was explored for psychometric properties through testing of its validity and reliability.

Content validity of the BAT was established through the use of a content validity index (CVI) as discussed by Burns and Grove (2005). The BAT was sent to four experts in emergency medicine, infectious diseases, and/or the medical aspects of biological defence. These experts all possessed an undergraduate degree in medicine and were employed by the Ministry of National Defence. All four experts had significant training in the medical aspects of biological agent defence and three of the four possessed graduate level schooling in the form of a Doctor of Philosophy (two) or a Master of Health Science degree (one). The one expert without postgraduate schooling is currently working full-time in the field of bioterrorism preparedness and has graduated from the Medical Management of Biological Casualties course that is offered by the United States Army Research Institute for Infectious Diseases. The BAT was sent to the experts for evaluation during the first week of August 2007. Respondents were asked to rate the

validity (on a four-point scale) of each item to the concept of interest (Lynn, 1986). Space was left for open comments to be entered if the respondent wished to do so. Results from all four respondents were grouped into two categories; the item is either irrelevant to the concept or relevant to the concept. Of the 18-items, the CVI was calculated to be 1.00, indicating a 100% agreement among all experts that all items were relevant to the concept being measured. No comments reflecting concerns regarding any item were recorded and the BAT was not modified prior to data collection.

Following the completion of data collection, reliability and construct validity of the awareness part and the knowledge part of the BAT was examined using Cronbach's alpha and exploratory factor analysis (principal component analysis) techniques. The awareness of the threat part of the BAT consisted of four items yielding a Cronbach's alpha of .619. Factor analysis of these items produced a multidimensional scale with two distinct factors using a varimax rotation with Kaiser normalization (thus preventing the covariance of factors) (Table 1). The first factor identified was external awareness with a Cronbach's alpha of .871. This included the items "Probability of an Attack in Canada in the next 10 Years" and "Probability of an Attack in their City in the next 10 Years." The second factor identified was internal awareness with a Cronbach's alpha of .687. This factor was composed of the items "Personal Preparedness for Bioterrorism" and "ED Preparedness for Bioterrorism."

Table 1 Factor Loadings of the Awareness Scale

Variable	Not Rotated		Rotated	
	Factor 1	Factor 2	Factor 1	Factor 2
PACA10A	.850	- .408	.940	.061
PACI10A	.845	- .407	.936	.059
PPBT	.551	.676	.149	.860
EDPBT	.405	.785	- .032	.882

PACA10A = Probability of an attack on Canada in the next 10 years.

PACI10A = Probability of an attack of their city in the next 10 years.

PPBT = Personal preparedness for bioterrorism.

EDPBT = ED preparedness for bioterrorism.

The internal consistency reliability of the original 12-item knowledge part of the BAT was poor, as indicated by a Cronbach's alpha of .353. Using squared multiple correlations, item correlations, and item deletion; poor items were successively deleted from the instrument. The process of item deletion was halted when it was apparent that further deletion would not improve Cronbach's alpha. As a result eight items remained, on which factor analysis (principal component analysis) was performed using varimax rotation with Kaiser normalization to examine the validity of the remaining set of items. The remaining eight items included all of the questions from scenario two and four as well as question on isolation and PPE from scenario number three. The analysis revealed that although items could load to form a multidimensional scale (three dimensions), the item loadings were not theoretically meaningful. Thus, all eight items were allowed to load on one factor that accounted for 58.91% of the cumulative variance in knowledge. A final Cronbach's alpha of .639 was achieved for the final 8-item knowledge scale. This acceptable but modest value warrants further investigation of the knowledge scale.

## Protection of Human Subjects

This research conformed to the Government of Canada Tri-Council policy on the ethical conduct of research involving humans (Interagency Secretariat on Research Ethics, 2005). Approval was requested and granted from the research ethics boards of the University of Windsor and two hospital sites where data collection occurred. Participants were invited to provide a free and informed consent in written form prior to the commencement of data collection. Participants were informed that their decision on whether or not to participate in the study would not affect their student/employment status, or any business that they may have or intend to have with the University of Windsor. All individuals who met the inclusion criteria were invited to participate. To ensure that all responses were anonymous no participants' identifying information was placed on the survey. In order to protect the privacy of responses, participants were advised to insert their completed surveys into a sealed envelope before dropping them into the data collection box. The investigator was the sole person responsible for collecting all completed surveys from the data collection box. Completed surveys were secured in a locked container to which access was limited to the investigator. Data entry into a computerized database was performed by the investigator who stored all data in a password-protected computer. No respondent identifiers were used in the computerized database. All data will be destroyed after five years of the study completion (American Psychological Association, 2001). Although the Ministry of National Defence, as part of the Canadian Forces Post Graduate Training Plan is funding this study, no conflict of interest exists for the researcher.

## Data Collection

Data collection commenced on September 3, 2007 upon ethics clearance from the various research ethics boards and was completed on October 17, 2007. The investigator visited the recruitment sites (the two EDs and the fourth year nursing classes) and explained the study to potential participants. In addition to the verbal and written explanations that were provided to those present during the investigator's visits, written descriptions of the study and the role of participants were left (for example in the mailbox of staff) for those who were not present during these visits. A follow up visit was made on a weekly basis to ensure all staff members were aware of the research project and had surveys at their disposal for completion. Upon their consent to participate in the study, the investigator provided the participants with the questionnaire and provided them with verbal instructions concerning the completion of the survey. In order to ensure the quality of data collection and avoid confusion, the investigator provided participants with the opportunity to ask questions or provide comments pertaining to the survey after the completion of the verbal explanation. Participants were given a choice to complete the survey on site or take it away and complete at the time and location of their convenience. Participants were instructed to drop the completed surveys in a secure data collection box that was available at each of the sites, or to return the survey to the investigator with the attached preaddressed stamped envelope. The completion time for the survey was approximately 20 minutes.

The return rate was relatively high with a total of 165 (86%) returned surveys. This included 100% of students ( $n = 73$ ), 80.6% of nurses ( $n = 75$ ), and 77.3% of physicians ( $n = 17$ ). With a fixed population of fourth year students and registered nurses

working in the EDs, the population captured by the survey could be calculated for these two groups. This survey captured 34.1% of the students and 61.5% of the registered nurses in the geographical area of interest. The physicians' recruitment rate could not be calculated because the number of physicians, working on locum or as residents in the EDs, was unknown during the data collection period.

### Data Analysis

SPSS 15.0 for Windows statistical software package was used to analyze the data. Data analysis procedures included data screening, basic descriptive statistics, univariate analysis (analysis of variance and Pearson's correlations), and multiple linear regression analysis. After completion of all data entry, 30 completed surveys were randomly selected and reviewed for the accuracy of the data input into the SPSS database. No errors were found. The database was also examined for out-of-range values and outliers due to possible errors in data entry. Once again, no such errors were found.

### *Data Screening*

Data screening involved searching for and managing any missing values, outliers, and multicollinear variables. A check for violations of the statistical assumptions of normality was performed amongst the continuous variables (El-Masri & Fox-Wasylyshyn, 2005; Munro, 2005).

Upon examination of the database for missing data, there were 14 variables with missing data (Table 2). Several authors suggest that when the amount of missing data are small (less than 10%), the variable should be retained for analysis as deletion techniques can introduce bias and/or result in larger standard errors due to the overall decrease in sample size (Cohen & Cohen, 1983; El-Masri & Fox-Wasylyshyn, 2005; Patrician,

2002). Other authors have suggested that variables with 40% or more missing data should be deleted (Raymond & Roberts, 1987). Therefore, given that the greatest amount of missing data in this study was 11.5% (for the age variable), all data were retained for analysis.

Table 2

Summary of Item Missingness

Variable	Valid	Missing	% Missing
Gender	163	2	1.2%
Age	148	17	11.5%
Level of Schooling	163	2	1.2%
Years in Profession	90	2	2.2%
Years in Emergency	90	2	2.2%
Working in USA	90	1	1.1%
Personal Preparedness	164	1	0.6%
ED Preparedness	162	3	1.8%
Scenario #1 – Decontamination	164	1	0.6%
Scenario #1 – Isolation	163	2	1.2%
Scenario #1 – PPE	164	1	0.6%
Scenario #2 – Decontamination	164	1	0.6%
Scenario #3 – Decontamination	164	1	0.6%
Scenario #3 – Isolation	164	1	0.6%



When the amount of data missing is small, and random in pattern it is feasible to use almost any technique for handling missing data (Tabachnick & Fidell, 2001). Group mean substitution was used to process the missing data. This technique is based on the concept of within-group homogeneity and is thought to provide a more accurate estimate of the actual data value than sample mean substitution due to the fact it minimizes the risk of attenuation of the between-group variances that occurs the sample is examined as a whole (Acock, 1997; El-Masri & Fox-Wasylyshyn, 2005; Tabachnick & Fidell, 2001).

Univariate normality was assessed by examining the distribution of the continuous variables for outliers, skewness, and kurtosis (Munro, 2005; Tabachnick & Fidell, 2001). Outliers were examined through the use of variable box plots and *z* scores. A *z* score value of more than  $\pm 3.29$  was considered an outlier (Field, 2005). Outliers were initially found in six of the continuous variables (Table 3). With very few outliers per variable, outlier values were Winsorized by assigning them the next closest value (Cohen, 1996).

Table 3

Outliers

Variable	<i>n</i>	# of outliers	% outliers	Value assigned
Yrs in ED	92	1	1.1%	28
Total # hours trg (training)	165	2	1.2%	24
# Hours trg in past 2 yrs	165	3	1.8%	16
History score	165	2	1.2%	-2 & 3
Agent score	165	1	0.6%	-3
Knowledge score	165	1	0.6%	6

Skewness and kurtosis were explored using a ratio technique by dividing the reported skewness and kurtosis statistics by the their respective *SEs*. Some authors (Pett, 1997; Stevens, 2002) suggest that the value to determine a departure from normality is  $\pm 1.96$ , while others suggest it is acceptable to use a cut off value between  $\pm 2.58$  and  $\pm 3.29$  (Tabachnick & Fidell, 2001). It as also been suggested in the statistics literature that one not need examine the ratio between the given skewness or kurtosis value and the *SE*, but rather look at the overall skewness and kurtosis value to determine a departure from normality. Kline (1998) states that the marker for departure from normality would be an absolute skewness value greater than 3 and/or an absolute kurtosis value greater than 10. Upon initial examination, only the variables of years in profession, history score, and agent awareness score exhibited normality (Table 4). Normality could not be achieved (using the cut off of  $\pm 3.29$ ) in the total number of training hours, number of training hours in the past two years, and knowledge score variables despite an attempt to transform the data using base 10 logarithm, natural logarithm, or square roots. However it was possible to find normality in the age and years working in ED variables though the use of a square root transformation (Table 5). If the Kline (1998) criteria is used all of the variables would be considered to be normally distributed as none of the skewness statistics are over three and none of the kurtosis statistics are over 10.

Table 4

## Initial Evaluation for Normality

Variable	Skewness			Kurtosis		
	Statistic	SE	Ratio	Statistic	SE	Ratio
Age	.667	.189	3.53	-.606	.376	-
Yrs in profession	.583	.251	2.32	-.522	.498	-1.05
Yrs in ED	1.191	.251	4.75	1.412	.498	-
Total # hours trg (training)	2.348	.189	12.61	6.511	.376	-
# Hours trg in past 2 yrs	2.352	.189	12.44	5.919	.376	-
History score	-.398	.189	-2.11	.437	.376	1.16
Agent score	-.083	.189	-.44	.649	.376	1.73
Knowledge score	1.112	.189	5.88	1.198	.376	-

Table 5

## Normality after Square Root Transformation

Variable	Skewness			Kurtosis		
	Statistic	SE	Ratio	Statistic	SE	Ratio
Age	.494	.189	2.61	-1.008	.376	-2.68
Yrs in ED	.119	.251	.47	-.559	.498	-1.12

*Basic Descriptive and Univariate Statistics*

Basic descriptive statistics including general frequencies of the categorical variables, as well as the *M* and *SD* of continuous variables were performed and are reported in chapter four. Analysis of variance (ANOVA) comparisons were performed on

independent categorical variables to identify how the knowledge score differs across categories of those variables. Pearson's correlations were performed to examine the relationship between the continuous independent variables (for example, age) and knowledge score.

#### *Multiple Linear Regression Analysis*

Prior to regression analysis, variables with more than two categories were dummy coded in order to include them in the regression model (Field, 2005; Tabachnick & Fidell, 2001). Independent variables that have a  $p$  value of  $\leq .25$  in the univariate analysis were included in the regression analysis. The selection of a liberal  $p$  value of  $\leq .25$  was used to avoid the unnecessary deletion of potentially significant independent variables from the final multivariate model (Hosmer & Lemshow, 2000). The regression model examined the predictors of knowledge pertaining to the health management of a bioterrorism attack. An alpha of .05 was used as the criterion to determine a significant finding in the multivariate analysis.

## CHAPTER VI

### FINDINGS

#### Sample Characteristics

##### *Demographic Data*

Tables 6 and 7 display the demographic characteristics of the study participants. The results suggest that only 2.7% ( $n = 2$ ) of registered nurses had advanced certification in emergency nursing. Of the physicians, 58.8% ( $n = 10$ ) had certification in emergency medicine and 11.8% ( $n = 2$ ) had certification in family practice from the Canadian College of Family Physicians. No participants had certification in infection control or a board specialty from either of the royal colleges.

Table 6

Sample Characteristics of Categorical Variables

	Total Sample	Students	Nurses	Physicians
Gender				
Female	81.8%	93.2%	86.7%	11.8%
Male	18.2%	6.8%	13.3%	88.2%
Schooling				
High School	37.0%	83.6%	0.0%	0.0%
College	33.9%	12.3%	62.7%	0.0%
University	29.1%	4.1%	37.7%	100.0%
American ED Work				
Yes	27.2%	N/A	30.7%	11.8%
No	72.8%	N/A	69.3%	88.2%

Table 7

## Sample Characteristics of Continuous Variables

	Total Sample		Students		Nurses		Physicians	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Age	31.4	10.6	22.5	2.6	37.2	7.8	44.3	8.6
Years in Prof	13.2	8.8	-	-	12.3	8.4	17.1	9.7
Years in ED	8.6	6.8	-	-	7.4	5.9	14.2	8.8
Total BT Hours	4.2	6.6	1.5	3.8	5.5	7.1	11.2	12.9
BT Hrs last 2 Years	2.4	4.5	1.3	3.6	3.6	5.1	3.1	4.5

*Information Access*

Most participants reported receiving their training in bioterrorism from within the hospital setting (32.7%;  $n = 54$ ), a university or college course (10.9%;  $n = 18$ ), or from reading journals or books (10.9%;  $n = 18$ ). Participants indicated that in the event of a crisis they would seek information from the hospital policy and procedures manual (66.7%;  $n = 110$ ), from the ED manager (51.5%;  $n = 85$ ), or from the Internet (43.6%;  $n = 72$ ). Only 16.4% ( $n = 12$ ) of students indicated that they received bioterrorism emergency training through university or college courses, while 50.7% ( $n = 38$ ) of registered nurses indicated that they received their bioterrorism emergency management training from within the hospital. Nursing students indicated that in the event of a crisis, they would look for information in the hospital policy manual (68.5%;  $n = 50$ ), from the ED manager (53.5%;  $n = 39$ ), or on the Internet (52.1%;  $n = 38$ ). Similarly, registered nurses reported that in the event of a crisis they would seek information from hospital policy manual

(66.7%;  $n = 50$ ), from the ED manager (58.7%;  $n = 44$ ), or from the ED educator (41.3%;  $n = 31$ ). The results suggest that physicians were most likely to have received bioterrorism training through a university or college course (29.4%;  $n = 5$ ), hospital setting (29.4%;  $n = 5$ ), or by attending a conference (29.4%;  $n = 5$ ). Physicians indicated that in the event of a crisis, they would primarily contact the Medical Officer of Health for information (76.5%;  $n = 13$ ), search the Internet (70.6%;  $n = 12$ ), look it up a textbook (64.7%;  $n = 11$ ), or ask a trusted colleague (64.7%;  $n = 11$ ).

#### *Awareness of the Threat of Bioterrorism*

Tables 8, 9, and 10 display the self report data pertaining to the awareness of participants of the probability and preparedness for a bioterrorist act, the awareness of past bioterrorism events, and the awareness of potential biological agents that may be used in terrorist acts. The results suggest that physicians did the best, followed by nurses, and nursing students.

Table 8

#### Awareness Probability and Preparedness

	Total Sample	Students	Nurses	Physicians
Probability of an Attack in Canada within the next 10 years				
Not happen	1.2%	0.0%	2.7%	0.0%
Low	33.3%	39.7%	25.3%	41.2%
Moderate	46.1%	47.9%	48.0%	29.4%
High	15.2%	9.6%	18.7%	23.5%
Will Happen	4.2%	2.7%	5.4%	5.9%

Probability of an Attack in their City within the next 10 years

Not happen	3.0%	2.7%	4.0%	58.8%
Low	40.6%	42.5%	34.7%	23.5%
Moderate	38.8%	41.1%	40.0%	11.8%
High	15.2%	13.7%	17.3%	5.9%
Will Happen	2.4%	0.0%	4.0%	0.0%

Personal Preparedness for a Bioterrorism Attack

Not Prepared	41.6%	46.6%	42.7%	17.6%
Low	42.4%	46.6%	41.3%	29.4%
Moderate	15.2%	6.8%	14.3%	52.9%
High	0.6%	0.0%	1.3%	0.0%
Fully Prepared	0.0%	0.0%	0.0%	0.0%

ED Preparedness for a Bioterrorism Attack

Not Prepared	15.8%	11.0%	21.3%	11.8%
Low	37.6%	39.7%	36.0%	35.3%
Moderate	44.2%	49.3%	40.0%	41.2%
High	1.8%	0.0%	2.7%	5.9%
Fully Prepared	0.6%	0.0%	0.0%	5.9%

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Table 9

## Historical Awareness

	Total Sample	Students	Nurses	Physicians
Oregon Restaurant Attack				
Yes	3.0%	1.4%	2.7%	11.8%
No	97.0%	98.6%	97.3%	88.2%
Chicago Water Scare				
Yes	6.1%	4.1%	6.7%	11.8%
No	93.9%	95.9%	93.3%	88.2%
Japanese Cult Attacks				
Yes	18.8%	2.7%	21.3%	76.5%
No	81.2%	97.3%	78.7%	23.5%
Hotel-Dieu Scare				
Yes	73.3%	65.8%	78.7%	82.4%
No	26.7%	34.2%	21.3%	17.6%
US Postal Anthrax Attack				
Yes	77.0%	71.2%	84.0%	70.6%
No	23.0%	28.8%	16.0%	29.4%
<i>M ± SD</i>	1.1 ± 1.2	0.6 ± 1.0	1.4 ± 1.2	2.1 ± 1.0

Table 10

## Biological Agent Awareness

	Total Sample	Students	Nurses	Physicians
Smallpox				
Yes	53.9%	52.1%	50.7%	76.5%
No	46.1%	47.9%	49.3%	23.5%
Lassa Fever				
Yes	9.1%	11.0%	4.0%	23.5%
No	90.3%	89.0%	96.0%	76.5%
Plague				
Yes	49.1%	50.7%	48.0%	47.1%
No	50.9%	49.3%	52.0%	52.9%
Botulism Toxin				
Yes	53.3%	56.2%	45.3%	76.5%
No	46.7%	43.8%	54.7%	23.5%
Tularaemia				
Yes	13.3%	12.3%	12.0%	23.5%
No	86.7%	87.7%	88.0%	76.5%
<i>M ± SD</i>	0.9 ± 1.4	0.6 ± 1.5	1.0 ± 1.3	1.9 ± 1.6

## Knowledge

The knowledge score of the entire 12-item questionnaire suggests that physicians had the highest level of knowledge ( $M = -2.0$ ,  $SD \pm 4.6$ ), followed by registered nurses ( $M = -3.0$ ,  $SD \pm 3.3$ ), and students ( $M = -3.9$ ,  $SD \pm 2.7$ ). The overall knowledge score for the entire sample was poor ( $M = -3.3$ ,  $SD \pm 3.2$ ). Descriptive frequencies on data pertaining to responses to items on the knowledge scale are provided in Table 11 with the correct answer bolded. The Appendix provides explanation of the four knowledge scenarios. On the surface the results suggest (without further statistical analysis) that physicians have the greatest amount of knowledge with respect to patient isolation and personal protection, while nurses have the greatest amount of knowledge with respect to decontamination.

Table 11

### Descriptive Frequencies in the Knowledge Scale

	Total Sample	Students	Nurses	Physicians
Scenario Number One				
Decontamination				
None	1.2%	1.4%	0.0%	5.9%
Clothes off	4.8%	8.2%	1.3%	5.9%
Shower	3.6%	2.7%	4.0%	5.9%
<b>Full</b>	<b>90.4%</b>	<b>87.7%</b>	<b>94.7%</b>	<b>82.4%</b>

Disposition

Resuscitation	1.8%	1.4%	2.7%	0.0%
Waiting Room	0.0%	0.0%	0.0%	0.0%
<b>Isolation</b>	<b>89.1%</b>	<b>95.9%</b>	<b>84.0%</b>	<b>82.4%</b>
Other	9.1%	2.7%	13.3%	17.6%

PPE

Standard	9.1%	5.5%	13.3%	5.9%
<b>Airborne</b>	<b>29.1%</b>	<b>30.1%</b>	<b>25.3%</b>	<b>41.2%</b>
Droplet	1.2%	1.4%	1.3%	0.0%
Contact	2.4%	2.7%	1.3%	5.9%
Special	58.2%	60.3%	58.7%	47.1%

Scenario Number Two

Decontamination

<b>None</b>	<b>16.4%</b>	<b>11.0%</b>	<b>20.0%</b>	<b>23.5%</b>
Clothes off	9.1%	15.1%	2.7%	11.8%
Shower	7.3%	11.0%	2.7%	11.8%
Full	67.3%	63.0%	74.7%	52.9%

Disposition

Resuscitation	3.6%	2.7%	5.3%	0.0%
Outside	20.0%	12.3%	25.3%	29.4%
Isolation	64.2%	79.9%	54.7%	41.2%
<b>Other</b>	<b>12.1%</b>	<b>5.5%</b>	<b>14.7%</b>	<b>29.4%</b>

PPE

<b>Standard</b>	<b>14.5%</b>	<b>11.0%</b>	<b>17.3%</b>	<b>17.6%</b>
Airborne	23.6%	23.3%	24.0%	23.5%
Droplet	4.2%	4.1%	4.0%	5.9%
Contact	11.5%	15.1%	6.7%	17.6%
Special	46.1%	46.6%	48.0%	35.3%

Scenario Number Three

Decontamination

None-1	5.5%	9.6%	1.3%	5.9%
None-2	1.2%	2.7%	0.0%	0.0%
Some	17.6%	17.8%	13.3%	35.3%
<b>Full</b>	<b>75.8%</b>	<b>69.9%</b>	<b>85.3%</b>	<b>58.8%</b>

Disposition

<b>Resuscitation</b>	<b>35.2%</b>	<b>24.7%</b>	<b>40.0%</b>	<b>58.8%</b>
Outside	1.8%	4.1%	0.0%	0.0%
Isolation	17.6%	20.5%	17.3%	5.9%
Quarantied	45.5%	50.7%	42.7%	35.3%

PPE

<b>Standard</b>	<b>16.4%</b>	<b>17.8%</b>	<b>16.0%</b>	<b>11.8%</b>
Airborne	17.0%	12.3%	18.7%	29.4%
Droplet	1.8%	2.7%	1.3%	0.0%
Contact	6.7%	6.8%	6.7%	5.9%
Special	58.2%	60.3%	57.3%	52.9%

### Scenario Number Four

#### Decontamination

<b>None</b>	<b>26.3%</b>	<b>27.4%</b>	<b>17.3%</b>	<b>35.3%</b>
Clothes off	9.1%	11.0%	6.7%	11.8%
Shower	9.1%	5.5%	8.0%	29.4%
Full	58.2%	56.2%	68.0%	23.5%

#### Disposition

Resuscitation	7.3%	5.5%	6.7%	17.6%
Outside	5.5%	4.1%	8.0%	0.0%
Isolation	70.3%	78.1%	65.3%	58.5%
<b>Other</b>	<b>17.0%</b>	<b>12.3%</b>	<b>20.0%</b>	<b>23.5%</b>

#### PPE

<b>Standard</b>	<b>18.8%</b>	<b>17.8%</b>	<b>18.7%</b>	<b>23.5%</b>
Airborne	35.2%	32.9%	34.7%	47.1%
Droplet	1.8%	2.7%	1.3%	0.0%
Contact	7.9%	11.0%	6.7%	0.0%
Special	36.4%	35.6%	38.7%	29.4%

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### Univariate Analysis

#### *Analysis of Variance (ANOVA)*

One-way ANOVA tests were completed between the knowledge variable and the variables of profession, highest level of schooling completed, gender, certification, and if the participant had worked in America in the past five years (Table 12). The knowledge

variable used for this analysis was a square root transformation of the raw knowledge score to correct for its severe skewness. Table 12 suggests that there was no mean difference in the groups across any of the variables.

Table 12

ANOVA of Knowledge

Variable	$M \pm SD$	F	$p$
Profession		2.46	.088
MD	1.26 $\pm$ .83		
RN / RN(EC)	1.04 $\pm$ .75		
Student	.85 $\pm$ .74		
Education Level		2.17	.118
High school	.85 $\pm$ .74		
College	.97 $\pm$ .74		
University	1.15 $\pm$ .80		
Certification		.288	.834
None	.95 $\pm$ .75		
CCFP(EM)	1.19 $\pm$ .99		
CCFP	1.00 $\pm$ .00		
ENC(C) / CEN	.87 $\pm$ 1.22		
Gender		1.56	.214
Female	.95 $\pm$ .76		
Male	1.14 $\pm$ .75		

Worked in USA		3.13	.080
Yes	1.17 ± .77		
No	.85 ± .73		

---

F = the omnibus F statistic for the one-way ANOVA  
Mean square root of knowledge = .98 ± .76

#### *Pearson's Correlations*

Two-tailed Pearson's product-moment correlations were completed between the square root of the knowledge score and the variables external awareness, internal awareness, number of years working in the ED, age, agent score, history score, and the number of bioterrorism training hours in the past two years. Table 13 displays the results of these correlations and suggests that only external awareness ( $r = .034$ ;  $p = .662$ ), years of experience in the ED ( $r = .149$ ;  $p = .156$ ), and age ( $r = .144$ ;  $p = .065$ ) were not associated with the knowledge score.



Table 13

## Pearson's Correlations: Continuous Variables and Knowledge

Variable	$M \pm SD$	$r$	$p$
External Awareness	$3.61 \pm .76$	.034	.662
Internal Awareness	$2.08 \pm 1.58$	.168	.031
Years in ED	$2.67 \pm 1.20$	.149	.156
Age	$5.53 \pm .89$	.144	.065
Agent Score	$.90 \pm 1.41$	.159	.041
History Score	$1.10 \pm 1.16$	.197	.011
Number of hrs trg in past 2 yrs	$2.42 \pm 4.15$	.188	.015

$r$  = Pearson's product-moment correlation

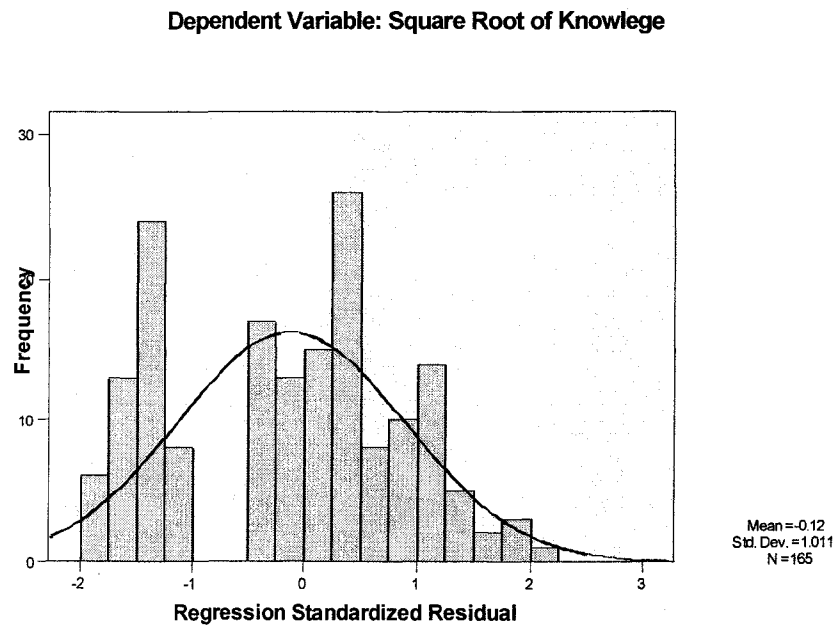
Mean Square root of knowledge =  $.98 \pm .76$

## Multivariate Analysis

*Exploring the multivariate assumptions*

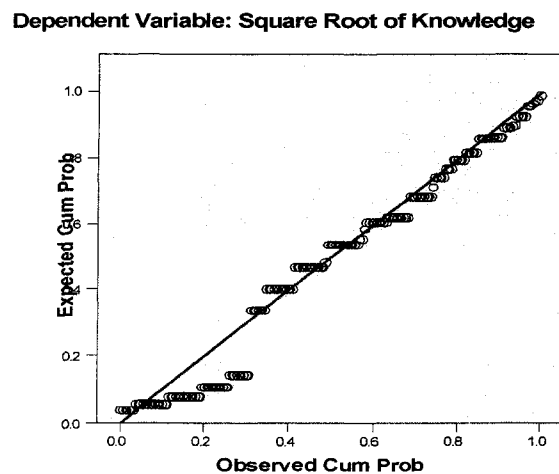
A histogram and a probability plot were created using the square root of the knowledge score as the dependent variable and all other variables as independent variables into the linear regression model of SPSS. The histogram was examined for the frequencies of the regression-standardized residual falling into a normal distribution curve (Figure 2). It showed an approximate normal distribution, with no visible skewness, leptokurtic, or platykurtic properties, indicating no issues with multivariate normality (Corty, 2007). A probability plot was created for the linear fit of plotted observed versus expected cumulative probabilities (Figure 3). It showed that the majority

of scores fall onto or near the normal distribution line, indicating that multivariate linearity is assumed (Field, 2005).



*Figure 2. Multivariate Normality*

**Normal P-P Plot of Regression Standardized Residual**



*Figure 3. Multivariate Linearity*

Both Mahalanobis and Cook's distances were performed to explore multivariate outliers. Mahalanobis distance "measures how much the case's values of the independent variables differ from the average of all cases. Therefore, a large Mahalanobis distance identifies a case as having extreme values on one or more of the independent variables" (SPSS, 2005, p.433). The largest Mahalanobis score found was 6.75. Given that the critical value of a chi square distribution using 11 degrees of freedom (the number of independent variables) and a  $p$  value of .001 was 31.6, the calculated Mahalanobis distance was not significant, indicating the presence of no multivariate outliers. Cook's distance is a measure of the overall influence of all cases on the model. Values of greater than one may be a cause for concern (Cook & Weisberg, 1982). Although not required due to the nonsignificance of the Mahalanobis distance, examination of the Cook's distance revealed no presence of any influential data points (none had a Cook's distance of  $\geq 1.0$ ).

Multicollinearity is an undesirable situation that occurs within multiple regressions where one or more predictor variables are highly correlated with the other predictor variables (Cohen, 1996). Schroeder (1990) suggests a greater than .85 bivariate correlation between independent variables creates a situation of multicollinearity. Tabachnick and Fidel (2001) provide for a higher bivariate correlation of .90 before multicollinearity presents as a statistical problem. Collinearity diagnostic statistics such as tolerance, variance inflation factor (VIF), and condition index were examined. VIF indicates the strength and the relationship of the independent variables (Field, 2005). Myers (1990) and Schroeder (1990) both suggest a VIF of 10 is indicative of multicollinearity. The data revealed that the highest VIF was 1.068, indicating no

multicollinearity was present. Tolerance is the reciprocal of VIF ( $1/\text{VIF}$ ). Field (2005) has indicated values below .1 indicate serious problems, whereas Menard (1995) suggests values below .2 may be of concern. The lowest tolerance value was .889, further indicating the absence of multicollinearity. Condition index values greater than 10 are suggestive of weak dependencies that may start to affect the regression estimates, whereas a value of over 100 indicates a serious predicament with respect to multicollinearity and the presence of numerical error (Belsley, Kuh, & Welsch, 1980). Collinearity diagnostics revealed that the highest condition index was 3.252 and this provided another indication of the absence of multicollinearity.

In addition to multicollinearity testing, Pearson's moment correlation test was performed between pairs of continuous variables to examine the possibility of bivariate collinearity. The results of these correlations (Table 13) showed no collinearity as evidenced by bivariate correlations that were all below 0.8. However, given that "the total number of bioterrorism training hours" and "bioterrorism training hours in the past two years" have a singular relationship (in that, training hours in the last two years is included in the total training hours), the variable "bioterrorism training in the last two years" was excluded from the model.

Table 14

Pearson's Correlations: Continuous Variables for Bivariate Collinearity

Variable	1	2	3	4	5	6	7	8
Internal awareness	1							
External awareness	.13	1						
Age (sqrt)	.09	.13	1					
ED experience	.04	.11	.7*	1				
BT training hours	.4*	.14	.34*	.17	1			
BT training hrs - past 2 years	.3*	.06	.14	.02	.72*	1		
History score	.03	-.09	.39*	.2	.22*	.11	1	
Agent score	.05	-.04	.20*	.16	.15	.06	.39*	1

(\*) Indicates a  $p$  value < .05; BT = bioterrorism; ED = Emergency department

#### *Linear regression analysis*

Prior to performing the linear regression analysis, categorical variables with more than three categories (profession and highest level of schooling) were dummy coded. Forward stepwise approach was conducted using a  $p$  value of .05 as the inclusion criteria and .15 as the removal criteria. All variables that had a  $p$  value of  $\leq .25$  in the univariate analysis were included in the regression model. The results in Table 14 indicate that only one variable, the internal awareness score, entered into the model with a  $R^2$  of .062. Table 15 shows the variables that were excluded from the regression model.

Table 15

Variables Included in the Model.

Variable	B	SE	$\beta$	<i>t</i>	<i>p</i>
Internal Awareness	.129	.053	.248	2.433	0.17

B = The unstandardized coefficients,  $\beta$  = The standardized coefficients

Table 16

Variables Excluded from the Model

Variable	$\beta$	<i>t</i>	<i>p</i>	Partial Correlation
College	- .066	- .628	.532	- .066
RN	- .052	- .487	.627	- .052
External Awareness	- .084	- .810	.420	- .086
Yrs in ED Sqrt	.140	1.372	.173	.144
Age Sqrt	.038	.367	.715	.039
Agent Score	.042	.405	.687	.043
History Score	.184	1.823	.072	.190
# Hrs Trg last 2 yrs	.186	1.737	.086	.181
Worked in USA	- .179	-1.773	.080	- .185
Gender	.121	1.773	.244	.123

 $\beta$  = The standardized coefficients

## CHAPTER V

### DISCUSSION

The overall state of the knowledge of Canadian ED clinicians with respect to bioterrorism management is unknown due to the lack of previous studies on this topic. With a credible threat to the Canadian population from a bioterrorist attack (Purver, 1995), a history of terrorists using biological agents to further their cause (USAMRIID, 2005), and the scientific availability of biological agents for which to use against a population (Rotz et al., 2002), ED clinicians could be faced with a sizable situation for which previous clinical experience poorly prepares them. With a professional mandate to respond to such a crisis, formal preparedness for such an incident is critical. During a bioterrorism incident one cannot fall back on past experiential learning acquired from incidents to which they have been previously exposed.

This study explored the awareness (threat, agent, and historical use) and previous training ED clinicians had in the field of bioterrorism. Specifically, it explored the core competencies of decontamination, personal protection, and isolation, as they are critical for the correct ED response to a bioterrorism attack. Fearing that ED clinicians would not have all the answers in their memory, the types of immediate references that the clinician would utilize to seek just-in-time information were also examined.

Overall, despite the low levels of formal or informal previous training, the lack of historical knowledge of biological agent use, and poor awareness with respect to the type of agents that may be employed by terrorist, study participants thought that a bioterrorism attack was probable. They reported the notable probability of a bioterrorism attack was not only in some distant part of Canada, but also in the city in which they work.

Participants were also able to self-articulate the perception of poor personal and moderate departmental preparedness for such an incident. This premonition was accurately reflected by a lack of knowledge base in the core competencies of decontamination, isolation, and personal protection. Upon examination of the factors influencing the knowledge of health care providers concerning the management of bioterrorism victims, only internal awareness was an independent predictor. That is, the knowledge of the ED clinician may have been influenced by how prepared the clinician personally felt and how prepared they felt their ED department was to respond to a bioterrorism attack.

### Demographics

The distribution of the sample in this study was anecdotally similar to the distribution of the ED staffing in Canada. The study population was composed of mostly female participants and the average experience in emergency care was 8.6 years. RNs in the sample were predominantly college educated (62.7%). Of the practicing clinicians, a notable number had worked in an American ED (27.2%,  $n = 25$ ). Surprisingly, the data suggested that American work experience did not confer additional training, awareness, or knowledge on the topic of bioterrorism, despite the recent (2002-2006) 6.1 billion dollar expenditure by the American government to prepare their health care systems for disasters such as bioterrorism (GAO, 2007).

### Level of Training

On average, the data suggest that physicians have twice the bioterrorism management training than nurses over the period of their career. Although training was found to be higher in this study than that of Ghilarducci et al. (2000), no provincial or national standard exists for what constitutes sufficient training. However, the CF nursing



occupation provides 55 hours of bioterrorism training at the start of a nursing officers career with a yearly (averaging 2.5 hours) refresher for all personnel (MND, 2000). The quantity of this training is substantially increased for nursing officers who are expected to be prepared to provide care to bioterrorism casualties. This standard is substantially higher than the amounts of training reported by participants in this study.

The state of bioterrorism education within the sampled university nursing program was dismal with a total average of 1.5 hours. This lack of bioterrorism education finding is congruent with the finding of Markenson et al. (2005), who reported that very few American schools provide any formal bioterrorism training within their curricula. The importance of training in the fundamentals of emergency bioterrorism care while in an undergraduate university program cannot be understated (Langan, Kater, & Aharoni, 2005), because it provides the foundations for further development and potentially comprises a substantial amount of the total training a clinician will ever receive. Although training is being conducted within the hospital settings, only one third of participants reported receiving such training within the sample studied.

#### Access to Information

The findings suggest that in a crisis situation, information on how to manage the bioterrorism emergency would be sought from a variety of sources internal and external to the ED. Participants suggested that, within the ED, they are more likely to consult with the departmental policy and procedure manual and seek advice on how to manage the situation from the ED manager. These two sources for information are within the locus of control of the ED and reinforce the importance of having an up to date bioterrorism reference within the policy and procedure manual. It also highlights the importance of

ensuring that key members of the leadership team are knowledgeable in the management of a bioterrorism event. The Internet was also identified as a likely tool to which participants would turn for information on how to manage the bioterrorism crisis. This finding could prove to be problematic because the information contained within the Internet is outside the control of the ED management and its content may not always be valid. Use of the Internet will force the clinician to be very critical of the information found and require scrutinizing for currency, authenticity, and applicability to the presenting situation (NATO, 2001; Purcell, 2004). This task could prove to be difficult for the clinician, faced with a stressful time sensitive crisis, who is unfamiliar with the fundamental concepts of bioterrorism casualty management (Craigie, Loader, Burrows, & Muncer, 2002). Having credible websites and resources bookmarked on ED computers prior to an emergency can mitigate the hazard the Internet provides as a just-in-time reference tool and fosters the rapid access to information (NATO, 2002).

#### Threat Awareness

The findings of this study suggest that almost all ED clinicians and nursing students believe there is some probability of encountering a bioterrorism attack within Canada in the next 10 years. The threat assessment with respect to probability of occurrence within Canada was considerably higher by the participants than that openly reported by the Canadian Security Intelligence Service (Purver, 1995).

Despite the higher-than-real assessed probability of an attack, participants knew little of past historical attacks or biological agents a terrorist may employ against a population. The score on historical knowledge was lowest in students and highest in physician respondents. Overall, participants were largely unaware of the largest (in terms

of casualty yield) bioterrorism event (the 1984 Oregon restaurant attack), unaware of the first threat of bioterrorism in North America (the 1972 Chicago typhoid water supply plan), and unaware of the multiple attempts in the 1990s by the Aum Shinrikyo to attack the Japanese population with biological agents. Study participants were largely aware of a 2007 bioterrorism scare at a local ED and aware of the postal anthrax attacks that affected the United States in 2001. These findings could be reflective of the change in global terrorism awareness since 11 September 2001 (Michaels, 2002), where North Americans are more concerned over threats and actions that terrorists could take against them (Gartenstein-Ross, 2007; Millward, 1993). Another possibility could be attributed to the theory of knowledge half-life (Machlup, 1962), which suggests that people are more likely to be aware of information to which they have been recently exposed (such as in news reports).

With respect to the knowledge of the biological agents that a terrorist is most likely to use, participants once again scored poorly. Students had the lowest score, while physicians had the highest score. Of greatest concern was the finding that most participants were unaware that Lassa fever may be employed as a bioterrorism agent and were unaware that highly infectious tularemia may be used as a weapon. Although the awareness results for plague, smallpox, and botulism toxin were better, they were disconcertingly low for clinicians responsible for a frontline response. The five agents presented in this study comprise 71.4% of all agents considered to be of highest likelihood to be used by a terrorist according to the CDC (Rotz et al. 2002). Without the ability to know which agents might present in the ED after a bioterrorism attack, ED clinicians cannot adequately detect, treat, or protect themselves from the infectious

process (USAMRIID, 2005). In comparison to Chen et al. (2002) who examined American family physicians awareness of bioterrorism agents, the findings of this study were similar for tularemia, lower for smallpox, and higher for plague and botulism.

### Knowledge

Knowledge pertaining to the key concepts of decontamination, personal protection, and isolation were examined in this study. In general, the findings suggested that knowledge of the participants was very low. The fact that participants not only lacked knowledge in many situations, but were likely to select answers that will be of counter productive nature was especially concerning. Once again, knowledge was found to be lowest in students and highest in physicians, although the overall knowledge of the sample was disconcertingly poor, regardless of profession.

With respect to knowledge of decontamination, the findings were somewhat positive. Practicing clinicians articulated the need to decontaminate an obviously contaminated casualty. Further, the large majority understood the importance of decontaminating all casualties regardless of their injuries prior to admittance into the ED. However, it is concerning that a group of physicians and nurses indicated that they would admit a casualty requiring urgent medical treatment into the ED prior to decontamination. A situation where a contaminated casualty gains admission to the ED prior to decontamination is the worse case scenario (Levitin et al., 2003). This action compromises the environmental safety of the ED infrastructure (possibly rendering the ED closed for several months while structural decontamination is undertaken) and places both clinicians and other patients in the ED at considerable risk of acquiring an infectious disease (GAO, 2003). Practicing ED clinicians were most likely to over decontaminate

casualties (that is, initiating decontamination when not required). While this is preferable over under decontamination (that is, not decontaminating a casualty who requires decontamination), it still presents problems in the overall management of biologically contaminated casualties (Currance, 2005). These problems include a physical and psychological risk to staff and patients by working in personal protective equipment (NATO, 2004), the disruption of regular ED care, the cost of committing disposable resources (United States Department of Justice, 2002), and the image portrayed to the media. This study examined two situations where decontamination did not need to occur. One was a small group of reliable patients (police officers) who were decontaminated on scene by a reliable decontamination system (the fire department hazardous material team), while the other was a patient who obviously did not require decontamination due to his presenting story and possible agent of exposure. In the first case, very few of the respondents would allow the police officers into the ED for medical examination, while the majority would force a full second decontamination at the ED. In the second case, few participants understood that this patient did not pose a risk to the ED and opted not to decontaminate, while the majority would once again force this patient needlessly through the decontamination process.

With respect to the practice of isolation, clinicians understood the importance of isolating a bioterrorism casualty who presents with exposure to a potentially highly contagious disease (in this case Ebola). Overall, practicing clinicians tended to over estimate the need for isolation. The results show a lack of understanding of the facts that decontamination most often negates the need for isolation (Veenema, 2007b), that ricin exposure is not a condition for which isolation is warranted (USAMRIID, 2005), and that

the technique of quarantining patients is not the standard of practice (Hoffman, 2003). This lack of knowledge could result in unwarranted commitment of resources (isolation rooms) and the potential of needlessly treating (such as in scenario three, see Appendix A) casualties with traumatic injuries that need resuscitation in the isolation room. Performing trauma resuscitation outside the resuscitation area (where all supplies are located, drills are practiced, and space is optimally designed) could result in suboptimal care (Huddy, 2002).

Participants scored the poorest with regard to the personal protection component of knowledge. Once again, respondents universally over estimated the requirement for PPE. In all but the last scenario, the respondents chose that they would use a “category C protective garment” complete with air purifying mask to care for patients within the ED. This was the highest level of protection offered and would involve the use of a full-face air purifying respirator or powered air purifying respirator, chemical resistant clothing, inner gloves, chemical resistant outer gloves taped to the suit, and chemical resistant boots with a steel toe and shank (Currance & Mailliard, 2005). This robust level of protection is usually reserved for decontamination line personnel, especially those involved in chemical (versus biological) agent decontamination (Dickens, 2002; Veenema, 2007b). Multiple problems exist with over estimating the PPE requirement. Physical and psychological performance degradation occurs when staff is burdened by such levels of PPE resulting in a net decrease in the ability to provide care (NATO, 2004; Veenema, 2007b). It is also possible that receiving care by hospital staff in “space-suits” would have an adverse effect on the psychological well-being of the patient (Mason & Lyons, 2003). Another issue would arise when staff members are not provided this level

of protection (as the hospitals EDs do not have it), despite expectations that they be protected in such a manner. Such situation could result in MD/RN refusal to work and other human resource issues such as occupational health and safety claims and a stop work order by a union (Veenema, 2007b). The issue of desiring a higher level of protection for which to provide care is related to the misunderstanding of the decontamination process, lack of knowledge that most biological agents are not communicable, and the ability of self protection using commonly available infection control PPE postures such as airborne, droplet, contact, and standard precautions.

### Predictors of Knowledge

On examination of the factors associated with the knowledge of health care providers in the ED concerning the management of the victims of bioterrorism, only internal awareness was an independent predictor. This finding is congruent with that of Chen et al. (2002) who reported that bioterrorism preparedness within American family physicians was reflective of increased knowledge. This finding reinforces the logic that people who think they are prepared are knowledgeable with respect to how to react, and those who know they are not prepared most often know they lack knowledge in the given area. Nonetheless, it was surprising that none of the other variables examined in the model (for example, profession, external awareness, agent awareness, awareness of past bioterrorism events, bioterrorism training, and having worked in the USA) were significant.

With respect to training, one would hypothesize, based on the CF NBC framework used for this study, that increased training would be an independent predictor of knowledge. This hypothesis did not hold true as the minimal amounts of training

reported by participants with regard to the fundamentals examined here (decontamination, isolation, and personal protection) did not predict knowledge. Further examination of this part of the conceptual framework should be conducted to discover if this finding is a one-time occurrence or rather is a recurrent in other studies resulting in the need for a revision of the framework.

### Implications and Recommendations

The findings of this study add to the body of knowledge within disaster preparedness, medical bioterrorism defence, and emergency nursing/medicine. They are particularly relevant to the setting where the data was collected and should not be generalized beyond these EDs. The overall low knowledge regarding how to respond to a bioterrorism attack serves as a warning to planners, clinicians, policy makers, educators, and managers that we are ill prepared to deal with the health consequences of a bioterrorism attack.

### *Recommendations for Practice*

This study reinforces the need identified by the USPHS (2004) for ED clinicians to be competent in the management of bioterrorism casualties. As part of this competency, managers must ensure that staff are cognizant of the risk of a bioterrorism attack, biological agents that could be potentially used, how to decontaminate casualties in a timely manner, and how to protect themselves and others from potentially infectious situations. By ensuring that hospitals have knowledgeable teams of ED clinicians that are prepared to manage victims of bioterrorism, the preparedness for future naturally caused pandemics is simultaneously bolstered. It has been reported by Goldstein (2003) that the American investment in biological terrorism preparedness allowed the rapid response to



the 2003 SARS epidemic. To this avail, managers should train their staff on the topic of bioterrorism, policy makers should fund training and incorporate minimal levels of training into policy documents, and ED clinicians should seek out information on the topic of bioterrorism in order to provide competent care to potential bioterrorism casualties.

This study also suggests the need for ED managers, ED educators, and the Medical Officer of Health to be experts on the topic of the management of bioterrorism casualties. According to this study, ED staff will turn to these key players in the event of a bioterrorism emergency for direction, advice, and procedural guidance. Given the overall low level of knowledge on the subject, if these people are not knowledgeable, not only may a leadership crisis ensue (MND, 2007), but the whole ED system may fail. The study also suggests the need for the policy and procedure manual within the ED to have clear, concise, and accurate guidelines on the management of bioterrorism casualties.

#### *Recommendations for Teaching*

This study supports the statements by Markenson et al. (2005) and the International Nursing Coalition for Mass Casualty Education (2003) on the importance of formally educating both nurses and physicians on the topic of bioterrorism. Given that low levels of knowledge were reported within all professions in this study, it is evident that the educational system is failing health care providers with respect to bioterrorism education. All undergraduate medicine and nursing programs need to contain information on the threat, historical precedence, and potential biological agents, and management of bioterrorism victims. This hazard identification and risk analysis approach to disaster management is well supported in the literature (Ciottone, 2006; Coppola, 2007).

Subsequent to the understanding of the problems, students should be educated on the fundamentals of response such as decontamination, isolation, and personal protection from infectious agents. Such fundamental training should be expanded to graduate programs, specialty training for ED clinicians, and professional maintenance of competency training within the ED settings.

#### *Recommendations for Research*

Given that this was the first study to examine the knowledge of bioterrorism management amongst ED clinicians, the findings need to be replicated before they can be generalized. It would be useful to have this study conducted over multiple sites within Canada in order to examine regional variance and gain a better understanding of the overall preparedness for a bioterrorism attack. It also is recommended that research be conducted on how the topics surrounding bioterrorism and infectious diseases are being taught within medical and nursing undergraduate programs, and how comfortable new graduates feel about applying these skills to practice. Finally, it is recommended that the BAT be subjected to further testing to allow for the inclusion of a greater number of questions that examine one situation. This would allow for a greater sampling of the concepts, prevent one erroneous answer from discounting knowledge on a topic, and ideally increase the ability to capture the essence of knowledge on this topic.

#### *Limitations*

A data collection technique that relies on self-report has the potential for response bias (Burns & Grove, 2005). It is possible that respondents, despite being asked not to do so in the introductory letter, spoke to their colleagues about the questions or looked up the answers prior to submitting their results. Additionally, the study design prevents the

declaration of any manner of causality. Although the descriptive methodology used in this study served a distinct purpose, the underlying methodology nonetheless remains a limitation to the advancement of the science. Future study methodologies should take this into account in order to advance the state of knowledge within this topic.

The BAT was a new research survey created specifically for this research. Although great care was taken to psychometrically validate it prior to use, limitations may be present in any new tool when it is first used. There is a risk that the BAT did not fully capture the maximum level of variance with respect to awareness and knowledge. Future mitigation of this risk can come with repeated use of the tool, further psychometric validation, and revision if required.

### Conclusion

The risk of another bioterrorism attack occurring and need for Canadian ED clinicians to provide care to those affected is probable. Despite having EDs that are centres for excellence for emergency care, the sample was not prepared to deal with the casualties that are resultant from a bioterrorist attack. This lack of preparedness is directly impacted by the lack of awareness and knowledge among ED clinicians with respect to management of bioterrorism casualties. The risk of poorly responding to a bioterrorism event is compounded by the fact that education on the topic of bioterrorism casualty management does not provide students with the fundamental required knowledge. By increasing the level of awareness and knowledge with respect to bioterrorism casualty management, we can deter the use of biological agents by terrorists and better serve patients who seek assistance after an attack has occurred.

# APPENDIX: Questionnaire Sample

## Awareness and knowledge of bioterrorism management amongst emergency department clinicians: An exploratory descriptive study

Demographics and Characteristics	
<b>1- Profession</b> <input type="checkbox"/> MD <input type="checkbox"/> RN / RN(EC) <input type="checkbox"/> 4th Year Nursing Student	<b>2- Highest Level of School COMPLETED</b> <input type="checkbox"/> High School <input type="checkbox"/> College <input type="checkbox"/> University
<b>3- Gender</b> <input type="checkbox"/> Female <input type="checkbox"/> Male	<b>4- What is your age in years? _____</b>
<b>5- Certification (if any)</b> <input type="checkbox"/> FRCPC / FRCSC <input type="checkbox"/> CCFP(EM) <input type="checkbox"/> CCFP <input type="checkbox"/> ENC(C) / CEN <input type="checkbox"/> CIC	
<b>Nursing Students, please skip to question # 9</b>	
<b>6- How many years have you been practicing in your profession?</b> _____ years	
<b>7- How many years have you been practicing in the field of emergency medicine / nursing?</b> _____ years	
<b>8- Have you worked full or part time in an American hospital in the past 5 years?</b> <input type="checkbox"/> No <input type="checkbox"/> Yes	
<b>9- Estimate the total number of hours of education and/or training you have received in the area of biological terrorism. Estimated number of hours: _____</b>	
<b>10- Estimate the number of hours of education and/or training you have had <u>in the past 2 years</u> in the area of biological terrorism. _____ hours</b>	
<b>11- I have received training in biological terrorism from (check all that apply):</b> <div style="display: flex; justify-content: space-between;"> <div> <input type="checkbox"/> University / College courses  <input type="checkbox"/> Internet courses  <input type="checkbox"/> In-hospital training  <input type="checkbox"/> Internet reading         </div> <div> <input type="checkbox"/> Government courses  <input type="checkbox"/> Conferences  <input type="checkbox"/> Journals / Books  <input type="checkbox"/> Other, please specify: _____         </div> </div>	

**12- If you required information while managing a biological terrorism situation in the emergency department, you would look (check all that apply):**

- ☐ In a textbook
- ☐ In the policy and procedures manual
- ☐ On the Internet
- ☐ On your PDA
- ☐ you would telephone a colleague whom you trust
- ☐ You would telephone the emergency nurse educator
- ☐ You would telephone the emergency department manager
- ☐ You would phone the infectious diseases physician on call
- ☐ You would phone the Medical Officer of Health at the Health Unit
- ☐ Other \_\_\_\_\_

**Bioterrorism Assessment Tool - Part I**  
**Awareness of the Threat of Bioterrorism**

**1- I feel the probability that Canada will be affected by a biological terrorism incident in the next 10 years is:**

- ☐ It will not happen    ☐ Low    ☐ Moderate    ☐ High    ☐ Certain it will happen

**2- I feel the probability of my city being affected by a biological terrorism incident in the next 10 years is:**

- ☐ It will not happen    ☐ Low    ☐ Moderate    ☐ High    ☐ Certain it will happen

**3- The level of preparedness I have to respond to a biological terrorism incident is:**

- ☐ Not prepared    ☐ Low    ☐ Moderate    ☐ High    ☐ Fully Prepared

**4- The level of preparedness my emergency department has to respond to a biological terrorism incident is:**

- ☐ Not prepared    ☐ Low    ☐ Moderate    ☐ High    ☐ Fully Prepared

**5- Please identify all of the following actual or threatened incidents of bioterrorism that you are aware of (check all that apply):**

- |  |   |
|--|---|
| <input type="checkbox"/> Chicago (O'Hare) Airport find         | <input type="checkbox"/> Sydney Olympic Games scare       |
| <input type="checkbox"/> Toronto Chinatown laboratory find     | <input type="checkbox"/> Hôtel-Dieu ED envelope scare     |
| <input type="checkbox"/> Oregon restaurant attack              | <input type="checkbox"/> Ottawa Canada Day incident       |
| <input type="checkbox"/> Chicago city water attack plan        | <input type="checkbox"/> American postal mail attacks     |
| <input type="checkbox"/> Japanese cult (Aum Shinrikyo) attacks | <input type="checkbox"/> New York supermarket attack plan |

**6- Please identify all of the following diseases that pose a HIGH threat of use as a biological terrorism agent (check all that apply):**

- |   |   |
|---|---|
| <input type="checkbox"/> Dengue                       | <input type="checkbox"/> Plague         |
| <input type="checkbox"/> Human immunodeficiency virus | <input type="checkbox"/> Botulism Toxin |
| <input type="checkbox"/> Smallpox                     | <input type="checkbox"/> Leishmaniasis  |
| <input type="checkbox"/> Lassa Fever                  | <input type="checkbox"/> Tularemia      |
| <input type="checkbox"/> Polio                        | <input type="checkbox"/> Yellow Fever   |

**Bioterrorism Assessment Tool - Part II**  
**Knowledge of Bioterrorism Emergency Care**

**Number 1:**

A senior federal government official in a local office opened a package at his desk. Inside this package was an unknown quantity of a fine white powder. A letter inside the package indicated this powder was Ebola, and the person who opened the package was going to die. The official reports to your emergency department (by car) in a panic.

**Please select the BEST answer for the following questions:**

**Which (one) of the following statements is true regarding removal of the agent from this person?**

- ☐ No decontamination needs to take place, as the alleged biological agent is not on the person.
- ☐ Removal of clothes as soon as possible after entering the emergency department.
- ☐ A shower with hot water and soap in the emergency department.
- ☐ A full decontamination outside of the emergency department.

**After the response taken above, this patient should be initially triaged into what area?**

- ☐ The resuscitation area for immediate evaluation and possible stabilization.
- ☐ The waiting room, as the patient is not ill and not at risk of spreading the disease.
- ☐ The isolation room, as the patient could be contagious.
- ☐ Another area within the emergency department for further evaluation.

**What type of infection control precautions must staff use while caring for this patient in the emergency department?**

- ☐ Standard (gloves, gown, mask, and eye protection when appropriate).
- ☐ Airborne (standard precautions plus the wearing of N95 respiratory protection).
- ☐ Droplet (standard precautions and wearing a mask when within 3 feet of the patient).
- ☐ Contact (standard precautions with gloves and gowns).
- ☐ Special (standard precautions with a powered air purifying mask, and resistant (category C). protective garment

**Number 2**

A global trade organization meeting is taking place in your city. This activity has resulted in large protests. During one of these protests a group of four police officers are sprayed with an unknown liquid. Fearing it may be chemical or biological in nature they remove themselves from the containment line and are decontaminated by the on-site hazardous materials team. Despite being asymptomatic, as part of the police protocol they are brought to your facility (with notice of arrival) for examination, documentation, and treatment.

**Please select the best answer for the following questions:**

**These police officers require:**

- ☐ No decontamination needs to take place, as the hazardous materials team did it.
- ☐ Removal of clothes as soon as possible after entering the emergency department.
- ☐ A shower with hot water and soap in the emergency department.
- ☐ A full decontamination outside of the emergency department.

**After the response taken above, these patients should be triaged into what area?**

- ☐ The resuscitation area for immediate evaluation and possible stabilization.
- ☐ The outside, pending the evaluation by a biological detector to confirm they are clean of agent.
- ☐ Into one isolation room, as the patients could be contagious from biological agent exposure.
- ☐ Another area within the emergency department for further evaluation.

**What type of infection control precautions must staff use while caring for these patients in the emergency department?**

- ☐ Standard (gloves, gown, mask, and eye protection when appropriate).
- ☐ Airborne (standard precautions plus the wearing of N95 respiratory protection).
- ☐ Droplet (standard precautions and wearing a mask when within 3 feet of the patient).
- ☐ Contact (standard precautions with gloves and gowns).
- ☐ Special (standard precautions with a powered air purifying mask, and resistant (category C protective garment).

### **Number 3**

A parade is occurring downtown in celebration of an important event. Despite some of the controversy over this event a large crowd turns out on this sunny day in order to celebrate. There is an explosion and many people in the crowd are injured from the blast. For reasons not totally clear, the on-site emergency services commander feels this might be a conventional bombing with a chemical or biological agent release occurring at the same time. He activates the city emergency plan, and your emergency department is notified that decontamination operations are being set up on scene and casualties will be sent to your department. Five minutes later, people start arriving by taxi and personal car at your front door. Some of them look quite injured and are in physical distress.

**Please select the best answer for the following questions:**

**These people require:**

- ☐ No decontamination needs to take place, as the hazardous materials team is on the scene, and is in control of decontamination operation for this situation.
- ☐ No decontamination, as the likelihood of biological contamination is non-existent.
- ☐ No decontamination for the urgent / emergent casualties, as they cannot wait. All others will have their clothes removed and have a hot, soapy shower.
- ☐ A full decontamination outside of the emergency department for all casualties, regardless of the nature of their injuries.

**After the response taken above, the patients with serious trauma should be triaged into what area:**

- ☐ The resuscitation area for immediate evaluation and possible stabilization.
- ☐ The outside, due to the possibility of biological off-gassing through the wounds.
- ☐ Into one isolation room, as the patients could be contagious from biological agent exposure.
- ☐ Another area within the hospital which will be designated a "quarantined area".

**PLEASE CHECK THAT ALL ITEMS YOU WISH TO FILL IN ARE COMPLETE  
AND THEN TURN THE PAGE**

**What type of infection control precautions must staff use while caring for these patients in the emergency department?**

- ☐ Standard (gloves, gown, mask, and eye protection when appropriate).
- ☐ Airborne (standard precautions plus the wearing of N95 respiratory protection).
- ☐ Droplet (standard precautions and wearing a mask when within 3 feet of the patient).
- ☐ Contact (standard precautions with gloves and gowns).
- ☐ Special (standard precautions with a powered air purifying mask, and resistant (category C) protective garment).

**Number 4**

A Canadian Border Security Agency Customs Officer arrives at your triage desk. He informs you that he feels "unwell" with general malaise, nausea, and a headache. He notes his illness began sometime after his shift at the border. He noted that during work today he was in contact with an unknown brown powder in a shipment he was inspecting. Not thinking anything of it at the time, the shipment was cleared to pass into Canada. When he mentioned this to his wife (who is a biologist) she was concerned that he may have come into contact with Ricin (a biological agent), and this might be the cause of his presenting illness. When questioned about his activities after work he informs you he has changed his clothes, had a shower, ate dinner, and had a nap before coming to the emergency department.

**Please select the best answer for the following questions:**

**This gentleman requires:**

- ☐ No decontamination needs to take place, as the possible exposure took place 12 hours ago and he has since changed and showered at home.
- ☐ Removal of clothes as soon as possible upon entering the emergency department.
- ☐ A shower with hot water and soap in the emergency department.
- ☐ A full decontamination outside of the emergency department.

**After the response taken above, this person should be triaged into what area?**

- ☐ The resuscitation area for immediate evaluation and possible stabilization.
- ☐ The outside, due to the possibility of Ricin off-gassing through the respiratory system.
- ☐ The isolation room, as the patient could be contagious from biological agent exposure.
- ☐ Another area within the emergency department for further evaluation.

**What type of infection control precautions must staff use while caring for this patient in the emergency department?**

- ☐ Standard (gloves, gown, mask, and eye protection when appropriate).
- ☐ Airborne (standard precautions plus the wearing of N95 respiratory protection).
- ☐ Droplet (standard precautions and wearing a mask when within 3 feet of the patient).
- ☐ Contact (standard precautions with gloves and gowns).
- ☐ Special (standard precautions with a powered air purifying mask, and resistant (category C) protective garment).



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